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EDITORIAL.

INSPECTION OF STEAM-BOILERS.

IN our issue of March, we remarked upon the steps which were being taken by our city authorities in reference to the above subject, and we now again resume the thread of our narrative, to show how those first steps have been followed up. As was before stated, the honor and labor of preparing a draft of an ordinance, such as might meet the many requirements of the case, was conferred by the Committee on Law upon the members of the Franklin Institute. These, after a general discussion of the subject, appointed seven of their number, with the President, to take into consideration the various suggestions and drafts which had been offered, and from these and their own best judgment, to frame an ordinance which might be submitted to the City Councils, for their approval and adoption. The labors of this committee have been regular and continuous, and had nearly reached a conclusion, when the late fearful explosion, by which twenty-two lives were lost, caused every haste to be made, that action

might be taken while yet the minds of all were impressed with the sense of its momentous importance, and the criminality of any unnecessary delay.

The final reading and presentation of the ordinance to Councils were therefore effected with all possible despatch, and the action of the Committee on Law has been equally prompt. It now only remains for the Select and Common Councils to put in force, by the necessary enactment, these regulations, and all will have been done which can in this way be accomplished, towards the prevention of such calamities as we have had but too frequent occasion to deplore.

The draft of ordinance which has been thus prepared, (and which will be found in full in the next number of this *Journal*,) is the result of much thought, many discussions, and mature deliberation. Its various provisions have been framed with a joint regard to the security of the public and the rights and interests of manufacturers, and while the first has been provided for without limitation or compromise, the latter have received such attention that no unnecessary hardship or inconvenience need be occasioned.

If doubt remained in any mind as to the importance of such provision, the circumstances attending the late disaster must have enforced conviction. These circumstances are, in some respects, so remarkable that we may well devote some space to giving them a record.

In a five-story building, used for various processes of machine carpentry, such as turning and scroll-sawing, was placed a steam-engine, supplied by a pair of boilers located in a basement under the yard adjoining. Each of these boilers was sufficient alone to run the engine; and to allow of their being worked separately, a common globe or stop-valve was placed at the outlet of each, where connection was made between them and the engine, by a steam-pipe, to which was attached the *safety-valve and connections of the gauge*. Both were therefore shut off, and each boiler completely locked up, by a closing of this valve.

The regular engine-driver being sick, and a temporary substitute engaged for a few days, it happened that some disarrangement required the stoppage of the engine, and opening of the cylinder. To effect this last with convenience, the stop-valve on the boiler in use was closed, as it appears, by one of the proprietors, who took general charge of the machinery, the temporary engineer not knowing the arrangement of the valves. The boiler was thus locked up with forty-five pounds of steam, and the remaining bed of fire and hot fur-

nace walls, to generate more. The repairs occupied about one and a half hours, and when these were finished, it was determined to try the engine. The gauge indicating no steam, the engineer, who seems not to have known anything about the arrangement of the steam connections, but supposed that the steam had been drawn off into the drying kiln, ordered shavings to be thrown into the furnace. The attention of the proprietor, who had closed the valve, seems to have been directed elsewhere, and on the addition of a second charge of shavings, the boiler exploded with most fearful violence, hurling portions to great distances over the surrounding houses, and completely leveling the building to which it belonged.

Nearly thirty workmen were engaged at the time, on the various floors. Some few escaped with severe wounds, but most perished at once, or in the fire which broke out in the mass of ruin, and added tenfold to the horrors of the scene. Nineteen bodies, not quite crushed and scorched out of all human recognition, and three which could not be identified, bore horrible witness to the criminality of those whose want of care or judgment might have occasioned this catastrophe.

The proprietor above mentioned, Mr. Geasey, was killed by the explosion; the temporary engineer, though severely injured, may recover. The verdict rendered by the jury of experts, summoned by the Coroner, was as follows:

"That the deaths of G. W. Geasey and others were caused by the explosion of the boiler at the mill, No. 1026 Sansom Street.

"From the evidence before them, including that of several experts examined, the jury are of the opinion that the explosion of the boiler was the result of over-pressure, caused by the closing of the stop-valve placed immediately over the boiler, thus shutting of all communication with the safety-valve and pressure-gauge.

"The balance of the evidence, also, in the opinion of the jury, tends to show that the valve was closed by Mr. Geasey, to enable the repairs of the engine to be made.

"In the opinion of the jury, while the condition of the boiler as regards construction and material was thoroughly good, the placing of a stop-valve between the boiler and safety-valve and indicator of pressure, was a most unsafe and unjustifiable proceeding, neither warranted by example nor the opinion of competent engineers.

"It also appears that several other boilers of like construction have been put up by the same builders in this city, whereby the lives and property of our citizens are endangered.

"In view of this, as well as the lamentable occurrence which we have just had under investigation, this jury would reiterate what has before been so strongly stated, that action of our city authorities, by which proper oversight and inspection should be secured, is imperatively demanded, and should not be delayed, lest, as was before predicted, another terrible disaster should reveal the consequences of neglect."

An efficient system of inspection would, beyond doubt, have excluded such a fault of construction, and thus have prevented this disaster. One of the jurors, Mr. John Agnew, called attention to a similar case which occurred in 1857, on the steamer *Hetzel*, then in use by the United States Coast Survey. Two boilers were there similarly connected, and furnished with but one safety-valve. The stop-valve on one was closed and forgotten, and the boiler fired, until it exploded.

ENGINEERING ITEMS.

The Suez Canal.—We find in the *Cosmos* of June 5th, 1867, an extract from the *Nile*, of Alexandria, dated the 16th of May, giving an account of an improvement opened for the Canal of Suez. The canal company have commenced to carry from one sea to the other, in barges, all kinds of merchandise for transit across Egypt. In the number of the *Cosmos* there will be published the tariff of transportation and the circulars addressed by the President of the company to the principal Chambers of Commerce, as well as those of the agents of transit of the isthmus.

A core-box plane by E. W. Lewis, was exhibited at the last meeting of the Franklin Institute. This tool consists essentially of an appropriate frame and handle, arranged with an adjustable guide, by which the distance from the edge of the block may be regulated, and a cutter or bit supported by a central shaft placed longitudinally, and capable of rotation on its axis by a small worm-wheel, which receives motion from one finger of the hand holding the plane, by means of a button with a milled head, conveniently placed. This worm may be thrown out of gear by slacking a clamp-screw, and then allows easy adjustment of the tool. The bit or cutter being of very small length, this tool can be used to plane out recessed core-boxes with great facility, one end of the recess being first planed up, and then the other end finished by reversing the tool.

Three sizes are manufactured. No. 1 cuts for cores of from $\frac{3}{4}$ inch to $3\frac{1}{4}$ inches diameter. No. 2 cuts from $1\frac{3}{8}$ to $4\frac{1}{2}$ inches, and No. 3 from $1\frac{5}{8}$ to 8 inches. These tools are used in many of our largest machine shops, as that of Wm. & J. Sellers, of Merrick & Sons, &c., and are highly esteemed.

Consolidated coal-dust.—Many attempts have been made from time to time to utilize that material known as coal-waste, which in our mining region has been thrown aside until the waste heaps so accumulated, have threatened to rival in extent and elevation the natural mountains among which they find themselves. Such attempts have as yet, to the best of our knowledge, proved unsuccessful in a commercial point of view, in this country, though a very different result has been obtained abroad. Thus, in an article by M. L. Gruner, Ingénieur en Chef des Mines, which appeared in the October number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, and of which we published a brief abstract in the 52d volume of this *Journal*, page 62, it is stated that in France some twenty establishments are carrying on this manufacture, and produce yearly 500,000 tons; in Belgium some seven manufacturers turn out 400,000 tons, while in other countries the product, though less, is very considerable.

We have not before us the data which would render possible such a comparison as might explain the very different success attained in this country and abroad, but we know that in some cases the fault lay in the costly nature of the machinery employed, and in other cases it was to be found in the friable nature of the product obtained, which rendered its transportation troublesome and expensive. We have now before us specimens of consolidated coal-dust, labeled "Gerard fuel," and remarkable for several peculiarities, which makes us think that the process by which they are produced will not share the fate of its American predecessors. These specimens are cubical, some of them measuring about 1·5 inch on each edge, others about 4 inches. They may be thrown violently on the floor without sensible injury, and are thus proved to possess all requisite consistency, while their process of manufacture, which we shall proceed to describe, looks well in other respects. The coal-waste is carefully screened, by which means it is stated that 30 per cent. of good coal may be secured. The finer particles are then crushed between rollers of chilled iron, and are then mixed in a machine, much like that used for tempering clay with coal tar, steam being also admitted and flour

added, according to the patent, but not found to be important in practice. From the mixer, the hot, wet, tary dust passes into the moulder, where plungers force it into moulds with movable ends; so that when each block has been formed, the end is raised and a second and further push of the plunger, throws out the finished cube. The cubes so formed are packed closely in iron boxes and run into an oven, where they are heated to a temperature, which distils off as illuminating gas all the hydrocarbon of the coal tar. From all that has been published abroad on the subject, it seems that experience has demonstrated the efficiency of the following points of treatment:

1st. The thorough pulverization and wet mixing. 2d. The use of coal tar as a cement. 3d. The baking after compression. The process just described involves these points, and certainly produces most excellent results. If on practical trial it shall prove to possess the last but all important requisite of economy, it cannot but render the manufacture of artificial fuel here, what it is abroad, a regular and profitable branch of industry.

Stone-cutting by machinery.—A paper on this subject was read before the Society of Arts, by Mr. W. F. Cooke, in which are many points of interest. In the first place, it appears that much depends in such apparatus upon the employment of a tool easily made, readily repaired and capable of rapid adjustment, in the grasp of the machine. Such a tool is found in that of Mr. G. Hunter, which in shape resembles a screw blank, the head of the screw representing the cutting part, the shaft being that by which it is attached to and held in the revolving portion of the machine.

For other purposes a disk with conical edge (much like a blank screw-head), and held by a vice-like grip on its flat sides, is efficient, presenting three or even four fresh cutting faces by being slipped round in the "holder."

Machinery in which such tools are used has been employed with great success, not only for dressing blocks, but also for quarrying and tunneling.

Steam cultivation is reported upon most favorably by the Committee of the Royal Agricultural Society, who have been for a long time collecting information and statistics on the subject. It would appear that in England, steam proves itself in this, as well as in other departments, at once the most efficient and economical laborer.

Silver and lead in the hearths of blast furnaces.—Percy

in his work on Iron and Steel, mentions the discovery of silver-lead in a blast furnace of Sileria, made by tapping the hearth of the furnace below the tap-hole. Lately Mr. Wm. Thomas, Manager of the Tow Law furnaces of Weardale, obtained a large amount of the same precious metal by a like treatment, and is now daily tapping lead and silver from below the iron.

The Cuba and Florida cable.—We learn from *Engineering*, that Messrs. Rutty, Wightman & Co. have just chartered the screw steamer *Narva*, to lay the telegraph cable between Florida and Cuba. The well-known telegraph engineer, Mr. F. C. Webb, is engaged upon the work.

The Hoosac Tunnel.—In the last yearly report of this work by the present superintendent, Thomas Doane, we notice several items of general interest.

It appears that pretty extensive experiments have been made with drilling machines, of a pattern invented by the chairman of the Board of Directors, and have resulted in the abandonment of this process, on the ground of its greater cost and slower progress. These drawbacks, resulting, however, simply from imperfections in the proportioning of the machines, by reason of which they were constantly breaking, and thus occasioning delay and expense. The work of the machines, while in good order, was rapid and effective, and capable of as advantageous application (as regards placing of holes and the like) as hand labor. The success which is reported to attend the use of machines of this description in the Mont Cenis tunnel, requires inquiry and explanation; since, from all that is now known, the character of the machinery used, is more complicated and less manageable there, than in the present case, where it has failed.

The plan of firing the charges by electricity, had also been thoroughly tried, and was now universally adopted, the coincidence of the explosion in a number of holes, greatly increasing the amount of rock displaced. The machine used to obtain the electricity, is simply described as the Ebonite machine.

In answer to an inquiry on the subject, Mr. E. S. Ritchie gives us the following description: "We had one of these machines made by Elliot, of London, taken from a blockade runner, and intended by our Southern brethren to be used in firing torpedoes. It consisted of two plates, about ten inches in diameter, and was nothing more nor less than a frictional electric machine, with a Leyden jar, made of vulcanized rubber and tinfoil rolled up, having a surface, I suppose,

of eight square feet, or possibly more, measuring both sides. There was nothing peculiar about it, except the making everything except the shaft, points, and connecting wires of hard rubber, and the quite ingenious compactness of the whole. The discharge was simply a Leyden jar spark."

Experiments with nitro-glycerine were also conducted, and with the most promising results. The saving of time and cost was most marked. Thus the progress in driving headings with this explosive, was doubled in rapidity with a reduction in cost, and in enlarging the progress was accelerated threefold, and with a reduction in cost less than in the previous instance, but yet notable. A trial with the **diamond borer** is also recommended as promising good results. This instrument, consisting of a tube armed at one end with a ring of small black diamonds, is in use, with success, at a tunnel which is being driven at Port Vendres, in France, as we learn from the *Civil Engineers' and Architects' Journal*, page 128. We have also a specimen of the core of rock extracted by the use of this tool.

Many other details of interest are given in this report of Mr. Doane, the Chief Engineer, as well as in that of Benjamin H. Latrobe, the Consulting Engineer, but we have not here space for their discussion. Mr. Latrobe estimates the total cost of the work, when finished, at $3,633,440, and the time required about eight years from the present date.

NOVELTIES IN CHEMISTRY AND PHYSICS.

Telegraph insulators.—We have just read in our admirable contemporary, *Engineering*, (p. 553,) an account of the various forms of insulator exhibited at the Paris "Exposition." The writer of that notice states, very truly, that the first requisite of an insulator is, that its substance should not transmit electric currents, and that after long exposure, its *surface* must also have a like condition, even after a thorough sprinkling with rain, or the deposit of moisture from warmer damp air.

As a matter of practice, the first property is of little interest, because there are so many bodies which possess it to a sufficient degree, but to reach the last, has required much research and endless experiment.

It is for this reason that ebonite, though so excellent an insulator

when new, so signally fails after exposure, as is mentioned in the article before us; but we can also add, from experiment, that a like fault is to be found with every other material mentioned, minute fissures or porosities showing themselves after a time, and these causing the surface to retain particles of water, in a continuous film.

One body has, however, been found to remedy this defect. The substance is paraffin. This substance makes and maintains an unchangeable surface, especially repellant of moisture, on all bodies which do not themselves change in shape, and which have been properly treated with it. This then narrows down our choice of other parts of the insulator, to the consideration of cost, mechanical strength and internal electrical resistance. These conditions, it is claimed, are best united in brown earthenware; but we think that they may be yet more thoroughly secured by a combination, in which *each quality* is *obtained in perfection* from a *different* material.

Thus, if the strength is secured from iron, the insulation from glass covered with paraffin, and the two are so united as to prevent self-fracture, from change of temperature, a very satisfactory result will have been achieved.

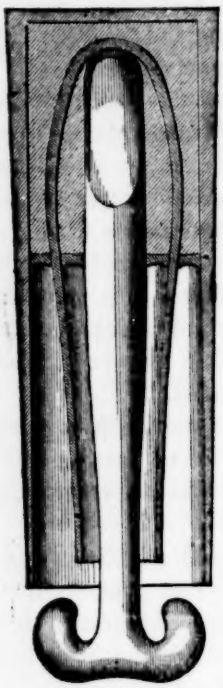
Now, this we honestly believe to be done by the Brook's insulator. Lest we should be misunderstood by any one, we here premise, that we say what we are about to state, from and with, no interest in this instrument or its inventor. We have simply read Dr. Cresson's report on the subject, (quoted in our last issue,) and witnessed and tried some experiments at the office of the Union Telegraph Company, where these instruments are in use. Being, by these means, assured of the merits of this insulator, we now write from these two motives.

Our pride in our country makes us anxious, as far as our ability reaches, to draw attention abroad to the fact, that in this, as in other particulars, America is not marching in the rear of progress. We therefore write these things for our foreign readers; while for our domestic subscribers, we feel in duty bound to call attention to every good thing which may be of use and value to them.

This premised, we will describe the Brook's insulator, and point out its peculiar merits.

An iron hook is sulphured into a little glass flask, or bottle, which, in turn, is secured, in like manner, into a deep cylindrical iron cup. After a few days, when the sulphur has undergone its peculiar shrinkage, paraffin is applied to the sulphur and glass, so as not only to coat every part, but to penetrate and fill every crevice.

It may be supposed by some, that the glass bottle thus situated, would be liable to fracture, but those who are acquainted with the behaviour of this substance in like circumstances, will remember its wonderful tenacity. A glass tube, rigidly clasped in a solid cap or covering, is one of the most troublesome things to break out which has ever tried our patience. In fact, these insulators will bear an immense strain without fracture, as we have seen by repeated experiments; or if they should, in some cases, yield, we know, from analogy, that the crack would run around the bottle, and would thus do no harm to the insulation, which only fears a lengthwise fissure into which external moisture may penetrate. Brown earthenware, from its softer nature, crushes under like conditions, and is destroyed by a strain which the glass endures with perfect impunity.



The peculiar shape of these insulators is another point worthy of notice. We miss in it the bell or umbrella form, so common in the complex instruments abroad. The reason for this is simply, that it is better to let drops come nearer, and pass by, than to stop them, even at a little distance, and by dashing them into fine spray, get them exactly into that condition, best fitted for penetrating the mouth of the cup and bottle. The bell shape has also the disadvantages of being a better mark for stone throwers, weaker, from its shape, and more likely to crack, and funnel-like in its tendency to accumulate dust and flying particles.

Before leaving this subject, we would call attention to an admirable, delicate and simple means of testing insulation, in these and like cases. Plunge the insulator in a bucket of water until thoroughly wetted inside and out; connect one pole of a powerful battery with one part of it, holding it with a wet hand by the other; then touch the tongue with the other pole of the battery. An escape of fluid which would not effect a very sensitive galvanometer may be thus very easily detected.

Visible sounds.—As is well known, sound is but another name for a certain kind of motion, which is propagated in air, or other

elastic bodies, by reason of alternate compressions and dilations, which we briefly designate as vibrations or waves. It is also known, that any change in density, affects there fracting power of a transparent body, as we see in the mingled currents of unequally heated (and therefore variously dilated) air over a stove.

We might, therefore, assume that these waves of sound might, by reason of their varying refractive power, become objects of sight, could we but secure means of sufficient delicacy for their inspection. Such means, it would appear, from a notice in *Siliman's Journal*, p. 391, have been devised by Dr. A. Töpler. A ray of light is so accurately focalized upon the object-glass of a telescope, that a very minute motion of a screen at that point, will cut it off entirely. Any irregular refraction introduced in the path of this ray would, however, cause a part so to proceed as not to be intercepted by the screen, and therefore to produce a visible figure in the telescope. The intense sonorous vibrations produced by an electric discharge, are thus found to show themselves as *visible rings or circles of light.*

Tucker's bronzed iron seems to excite some attention at the Paris Exhibition. This article, prepared by the Tucker Manufacturing Company of Boston, consists simply of iron, cast and worked in the usual manner, to which a bronze-colored surface is given by coating with vegetable oil and heating, in ovens to such a temperature as will at once decompose the oil, and slightly oxidize the iron.

Sugar prepared by diffusion, according to Roberts' process, has been made with great success by Mr. F. V. Minchin, at Aska, in the East Indies, as we learn from *Engineering*, p. 525.

The manufacture of Stearine by treatment with high-pressure steam, is extending in Europe. The fatty matter to be treated, is placed in a strong vessel, where it is maintained at a high temperature in contact with steam at a pressure of about two hundred and ten pounds, Under these conditions, the glycerine is liberated and dissolves in the condensed steam or water present, and the stearine, or, more properly, stearic acid, may afterwards be freed by pressure, in the usual manner, from olein or other more fluid bodies present in the original fat. A well arranged and efficient apparatus for conducting the above process, designed by M. Leon Droux, is figured and described in *Engineering*, p. 526.

Electricity as a superintendent of machinery.—In *Engineering* of May 24th, we find described a loom, controlled by electric apparatus, in such a manner, that the machinery is stopped the

moment any derangement occurs. Omitting practical details, which it would be impossible fully to explain, the general principle may be stated as follows: Each thread, and the important parts of the fabric, serve as insulators to metallic connections, otherwise forming a galvanic circuit, which, when closed, operates clutches for arresting the motion of the machine. Whenever, therefore, a thread breaks, or an opening occurs in the fabric, the circuit is closed, and the machine is stopped. This application, whatever may be its intrinsic value, illustrates the legitimate mode of employing electric force, as is mentioned in the paper above quoted. Electricity should be the brain and nerve force of machinery. It is out of place when it essays to perform mechanical work. Its true office is to do the thinking for the huge dumb brutes of iron and steel, who are best able to do our work.

Astrometeorology.—This term, which we might, perhaps, well translate into Climate of the Stars, or Weather of the Celestial Spaces, heads a very interesting paper in *Siliman's Journal* for May, by H. A. Newton, whose name is so well known in connection with the Meteoric Showers.

His important conclusions we will endeavor briefly to state as follows:

1st. That while the existence of rings or streams of meteorolites revolving about the sun, and yielding a supply of falling stars to the earth, when she passes through their region, is *a priori*, probable the result of existing observations is not satisfactory or conclusive, either in settling their extent, connection, or absolute existence in such a form.

2d. That no connection can be established between these meteoric bodies and terrestrial temperature, as was at one time attempted by St. Clair Deville, who suggested that these bodies might occasion cold by intercepting the sun's heat.

3d. That, as has been calculated by M. Schiaparelli, of Milan, and also by Mr. Newton himself, the origin of these meteor-producing formations may be conjectured to have been as follows.

We may well believe that matter is scattered throughout space in all grades of division. First, large stars. Second, small stars, the "star dust" of Herschel such as composes some of the compact but resolvable nebulæ. Third, comets; and fourth, cosmical clouds, in which the elementary masses are comparable to those we handle and transport on the surface of the earth. This last class we may well suppose to have been formed in space, in a manner analogous to the

crystallization of some salt from its solution, and that the aggregate volume of these cosmical clouds may be a notable portion of celestial space. The normal motions of such clouds would be similar to the grand progressions which we believe that we have traced in the universe of stars, and a result of identical forces. When any one of these cloud masses come within the range of the sun's attraction, it would be established in an orbit which must, (on certain grounds which it would be impossible here briefly to make plain, but which are well stated in the article before us,) be of vast radius, and therefore never come within the range of our observation, or a very greatly elongated conic section. The action of the sun's attraction upon such a loosely aggregated mass, moving in an orbit of the latter kind, would develop it into a parabolic current of great length, which might well consume centuries in flowing past the sun at the perihelion of its orbit, and be indeed a vast river, streaming on in space; or in time, by continuous elongation, at last develop into a closed curve or elliptic ring.

The number of such elliptic streams and closed rings may be very great, and their positions with reference to the plane of the elliptic infinite in variety. Their rarity will allow them to intersect without mutual disturbance. They may undergo progressive transpositions and deformations, like rivers which slowly change their beds.

4th. We may again ask if the clouds may not, in some cases, themselves be collections of comets. Professor Hock, of Utrecht, has found several double and triple systems of comets, which, at a remote epoch, were near each other, but have been separated. Thus, the comet III. of 1860, I. of 1863, and IV. of 1863, in the year A. D. 760 were distant from the sun 600·00, 600·42, and 600·25, respectively. Hock also believes that the comets of 1677 and 1683 belong to the same system. (Monthly Notices of Royal Astr. Soc., Vol. XXV., p. 243, and Vol. XXIV., pp. 1 and 204.) This is but one among many cases.

5th. The above result would lead us to ask if there might not be mixed systems, in which the ring or river of shooting stars might include one or more comets.

To answer this question, M. Schiaparelli has computed the elements of the mean orbit of the August meteors, and comparing them with those of the comet of 1862, III., as calculated by Dr. Oppolzer, finds a very close agreement, so that we are thus brought to the strange conclusion, that **the great comet of 1862 is simply the largest of the August meteorolites.** So, for similar reasons, we may in-

clude the comet of 1866, I, in the cosmical river which gives us our August star showers.

6th. We may, lastly, inquire, in the case of the November group of shooting stars, which, not being a complete ring, may be regarded as of late introduction to our system, what is the date of its origin, or first entrance on our horizon ?

When this group came into our system, it could only be thrown into its present circular orbit, by some powerful perturbing cause, as was the case of the comet of 1770. Moreover, as was the case with the above comet, the body so thrown into an orbit with small perihelion distance, returns of necessity to the orbit of the disturbing body. Now, we find the orbit of the November group extends to that of Uranus, and a very little further, and that these intersect just after the group passes its aphelion. By calculation, it appears that in the year A. D. 126, if we make a very allowable change on the ground of error and perturbation, the group would have actually run into the planet, and therefore might have been by it flung in towards the sun, as was the comet of Lexell, by Jupiter. On this hypothesis, therefore, it was in 126 that the November group made its début in solar circles, introduced by the kind offices of Uranus.

A specimen of hydrogen from Stellar space.—In connection with the above, most interesting and curious deductions from observation, we notice an equally remarkable conclusion from experiment, which has just been made. On page 230 of this *Journal*, Vol. LIII., we noticed that the eminent chemist, Graham, had made some curious experiments, by which it was proved that at high temperatures, iron would absorb several volumes of the gas to which it was exposed, and retain the same on cooling. He has now extended these experiments in a curious direction. Taking a piece of the meteoric iron of Lenarto, and heating it in vacuo, he obtains about 2·8 volumes of hydrogen. This would prove that when last red-hot, this meteorolite was immersed in a dense atmosphere of hydrogen. A large class of the fixed stars show strong hydrogen bands, and one of the bright lines found in all nebulæ indicates the same element, see this *Journal*, Vol. L., p. 284,) and the remarkable temporary star seen in May of 1866 indicated the presence of an intensely heated atmosphere of hydrogen. (See this *Journal*, Vol. XXXII., p. 138.) It would thus seem that the gas obtained from this piece of meteoric iron, by Professor Graham, is a literal sample of that which, among stellar bodies, is recognized by other properties, through the aid of

the spectroscope. For Graham's experiments, see *Chemical News*, p. 273.

Experiments illustrating diamagnetism, &c.—From the *Cosmos*, page 639, we translate the following remarks, made by M. Chautard, at the Academy, June 3d:

"All physicists know with what success the question of magnetism and diamagnetism of gases has been treated and resolved by M. M. Plucker, Faraday and Ed. Becquerel." * * * *

* * * "The use of a soap-bubble produced at the extremity of a clay-pipe, has been very successful, and has permitted me with oxygen to obtain any energetic attraction which can be easily converted into an oscillating motion, by the successive charging and discharging of the magnetism in an electro-magnet. I used a large electro-magnet of Ruhmkorff's, arranged for Faraday's experiments, and charged with a pile of from twenty-five to thirty of Binisen's cells. The solution of soap is mixed with a certain quantity of glycerine; the proportions are the same as those for the experiments of Flateau. The pipe is fixed in a pincers, at a convenient height, so that the bubble formed at one of the extremities is above the pole of the magnet, and at the distance of from two to three millimetres; the opposite end of the same pipe receives one end of india rubber tubing, which communicates with a vessel filled with oxygen; then, the experiment being prepared as we have already stated, you throw upon the bubble a flood of rays emanating from a lime light. There is then constructed in this way a sort of magnetic gas-pendulum, the motions of which, in an amphitheatre of six hundred persons, are as visible as those of an ordinary pendulum of an iron ball.

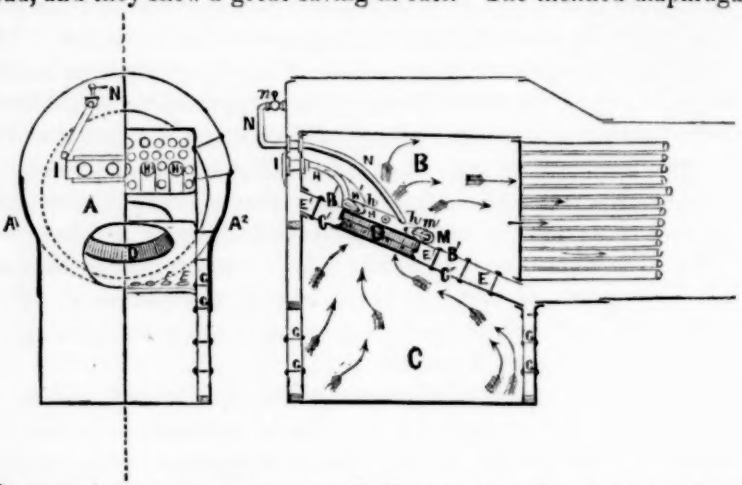
"Another experiment, which succeeded equally well, relates to diamagnetism of the vapor of magnesium in combustion. In causing the vessel to burn underneath the polar extremities of the electro-magnet, you see, as soon as the current passes, the column of smoke divide itself laterally and take the form of a well defined U. This is a very pretty experiment for a course, and very easily executed."

OUR NEW YORK CORRESPONDENCE.

New York, *June*, 1867.

Among the multitudinous efforts to improve the arrangement of locomotive boilers, the recent patent granted to Buchanan & Toucey takes a prominent place. The diagram accompanying this notice shows a longitudinal section, together with a semi-cross-section through

the fire-box. The boiler itself is of the usual form, the change being in the fire-box alone, which consists of two parts, separated by an inclined hollow diaphragm pierced by one or more holes, as D. Surrounding this hole on top, is a hollow cast iron ring, with nozzles *h*, extending radially inwards. This ring has communication with the outside air through pipes H′, having a slide I, by means of which the outer orifice is opened or closed. An internal gas pipe within this cast ring admits steam through nozzles *m*, contracted at mouth inside of those marked *h*, and described above. Steam is supplied to this gas pipe ring through the pipe N, in connection with the steam chamber, which connection may be opened or closed at pleasure, by means of the cock *n*. As will now plainly be seen, the effort of the inventors of this boiler is to make it a gas consumer, and the experiments thus far made, show that they have not worked in vain. There are now three such boilers in use on the Hudson River Railroad, and they show a great saving in fuel. The inclined diaphragm



gives much more water-space, and all unconsumed gases hot enough to ignite, if only a proper supply of oxygen is furnished, are concentrated so as to be caught in their outward passage by a blast of air through the nozzles *h*, forced in under a great steam pressure, through the contracted nozzles *m*. This gives a great advantage when an engine is standing, as the steam-pressure will force air over the unconsumed gases arising from the burning fuel, and complete their combustion. The chamber B shows one mass of flaming gases, which rush fiercely through the tubes to the smoke-stack. These boilers are so constructed as to have one seam of the fire-box plates running *parallel* to the inclined diaphragm (which is made by preference of

copper), so that by separating that row of rivets, burnt out portions may be renewed with very little difficulty, and with no displacement of the sounder parts not acted upon immediately by the fuel.

The new iron bridge over the Harlem River has been at last completed, and I will endeavor to send you some facts in regard to it. There are two spans of about one hundred and thirty feet each, and a draw span of some seventy feet water-way on either side. It is understood that about eighteen thousand tons of iron were employed in the construction of this bridge, quite an "item" for reflection.

The scientific publishers are gradually adding to their already large list of professional books, and although there is nothing especially new in that line, one occasionally stumbles across something very good. In the way of reprints, Van Ostrand has published a second edition of Whildin's "Strength of Materials," a well-known summary of our knowledge upon that subject. It is a pity that it was not brought more nearly up to date, in the way of experimental data, introducing, for instance, some of Mr. Fairbairn's experiments, to determine the effect of impact on girders. In any book, Mr. Fairbairn's name on the title page may be considered *prima facie* evidence of its worth. To him, more perhaps than to any one man, do we owe the development of wrought iron construction. His third series of papers, entitled "Useful Information for Engineers," has not long since been received in this country, and is a fit companion to the previous volumes. It is a compilation of various lectures and papers, most of which have appeared from time to time in the publications of the various societies and institutions. The volume before us opens with a series of lectures for the "moral and intellectual improvement of the engineer and artisan," and a valuable fund of useful and earnest suggestions they are, calculated to do an immense amount of good for the class for whom they were written. The *resumé* of the machinery department of the Paris Exhibition of 1855, is, especially at this time, an interesting one, besides being always valuable as a matter of reference, and the closing chapters on submarine telegraphy are carefully compiled from the most reliable data. To the American engineer, perhaps the most valuable portion of this book is that devoted to iron-roof construction, which, in addition to being conveniently practical in its application, is very well, although not profusely, illustrated. This topic is almost a verbatim reprint from papers that appeared in the *Civil Engineers'*

and Architects' Journal, by Messrs. Birckel and Karl Wessely, that of the former being republished in the *Journal of the Franklin Institute*, Vol. XLV. The analysis used is a simple application of the geometrical method of measuring forces, and is applied in reviewing good existing examples. To the constructive engineer, this subject alone is worth the price of the book. The "Decimal System," a paper by Dr. Craig, read before the American Association for the Advancement of Science and Art, has been published in a small volume by Van Ostrand, but contains nothing more than a simple explanation of the system, with a series of conversion tables, which look as if they might be taken from Prof. Rankin's excellent "Rules and Tables." The great question connected with the system (the merits of which all recognize), is how to introduce it as the true standard in those countries using arbitrary units of measure. This Dr. Craig has not touched upon, and consequently his book is of no more value than a great many other such compilations. The above publisher will shortly issue an elaborate work on the Brooklyn Water Works, embracing a full account of its construction and working.

As a matter of curiosity, I was called upon not long since to look at some operations of those destructive little borers in salt water, the *teredo*, which showed some very singular facts. An old scow which had been constantly in the water for ten years, was hauled up on shore to be shortened, and for that purpose was sawn in two. She had a flat bottom and slightly inclined sides. The bottom was composed of two-inch plank, all of which was white oak, with the exception of the extreme outside ones, which were of yellow pine. The sides were built of ordinary white pine plank. These different woods were bored by the *teredo*, in what would seem a curious disproportion; the bottom planks of hard white oak were riddled like a sieve, enough so as to impair their strength—the yellow pine was as sound as ever, the outside merely having been checked as it were, while the white pine sides were bored in amount intermediate between the other two. It would seem that the fibre and resin of the pines was distasteful to the *teredo*, while the oak, although the hardest wood of them all, could be ground out, as it were, in a powder. As a practical deduction from this single example, it would appear that yellow pine, white pine and white oak for pile foundations in salt water, were durable in the order of their naming, and it will be interesting if those who have had greater experience and observation in these matters, would either corroborate or disprove these facts.

A. P. B.

Civil and Mechanical Engineering.

(Continued from Vol. LIII., page 397.)

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

CHAPTER III.

SUPERSTRUCTURE OF ROADS—MACADAM AND TELFORD ROADS.

RELATIVE *importance of foundations and superstructure. MacAdam road. MacAdam's theory not sustained by Park experience. Stone breaking, by hand and by machine. Manipulation of materials, rolling, &c. Description of rollers. No thorough binding effect produced upon clean broken stone. Compression in rolling. The binding material used. Characteristics of MacAdam roads. Public preference for gravel roads. Telford road; advantages over MacAdam roads. Sub-pavement. Broken stone covering. Characteristics of Telford roads. Variation from Telford's form of sub-pavement. Stone breaking machine.*

AFTER what has been said in regard to the preliminary work of the Park roads, it will be seen that the mere surface material, that is generally looked upon as constituting the important feature of a road, forms but a part of the detail that is essential to good construction. The surface material forms, strictly, the superstructure of a road, and is, to a considerable extent, temporary; it wears away and needs to be renewed, while the foundation and other works that have been described, are (or ought to be) permanent and lasting. Dr. Lardner gave it as his opinion that the best engineering ability was required to make a good road; there is not much doubt, had he particularized, that he would have placed a large share of the ability on the side of foundation and preliminary work.

Three different kinds of superstructure, as has before been stated, have been resorted to in the construction of the Park roads, to wit: that of the *MacAdam road*, the *Telford road*, and the *gravel road*.

1st. *The MacAdam road.*—MacAdam's theory was, briefly, that small broken stones, when deposited on a road, and subjected to travel, together with heavy rolling, would arrange and adjust themselves together, by some mechanical law, in a compact solid mass, their

several sides and surfaces coming so perfectly in contact as to exclude all vacuities, and, in fact, to form practically a water-tight covering to the soil below.

The layer of stones, so formed, was regarded in the double light of a protection to the soil upon which it was laid, and of a "flooring" to facilitate the passage of vehicles. Its objects were merely to accomplish these purposes. The thickness of the layer (according to the theory) was to be regulated not with reference to its independent power of supporting the burdens brought upon it, but solely with reference to its usefulness as a film, supported by the underlying soil, as its foundation *to receive the wear of carriage wheels and horses' feet.*

The broken stones incorporated together in the manner supposed, were considered to form a coherent body, something like a layer of concrete.* The cementing property, as in the case of concrete, was not in reality claimed for it, but all the advantages derived from an actual cementation of the materials seemed to have been expected, in some way, to result from the process.

Without discussing these points, it is sufficient to say, that they have been contested by some of the best French and English road-makers, and are not found to hold good in common practice. Clean broken stones, devoid of all foreign material (such as sand, gravel or loam), as demanded by MacAdam, do not combine and solidify in the perfect manner assumed by his theory; they neither exclude water nor the action of frost from the material itself, or from the road-bed below, nor do they form so firm and coherent a covering to the soil as to prevent the unequal yielding and settlement and the occasional breaking up of the body of the material.

In the less rigorous climate of England, where this kind of road originated, and where it has been very extensively used, more favorable results have doubtless been attained than are practicable in this country, except in its more southern latitudes; but, under the most favorable circumstances, it is not conceded that the principles upon which the method is based have ever produced, or can produce, a road possessing the qualities and merits claimed by MacAdam. Never-

* Concrete is formed of broken stones, or gravel, cemented together by means of an intermixture with hydraulic cement and sand, forming, when the process of induration is complete, an artificial stone, similar to conglomerate or pudding stone, and not inferior to ordinary natural stones.

theless, with care, and some modifications of plan and materials, it is practicable to construct a very stable road in this climate, similar to, if not precisely in accordance with, MacAdam's ideal. Such a road is not believed to be the best or most economical for all purposes, and especially for a park or pleasure grounds, but it may be adapted to other circumstances and localities where special reasons exist in its favor.

The MacAdam roads of the Central Park have been constructed in the following manner:

The preparation of the road-bed and all the preliminary work, drainage, &c., that have been described in the preceding chapter, it will be understood, apply equally to the MacAdam road and to the other kinds of road that were successively constructed, (the descriptions of which will follow in their order.) The process of construction here described commences, therefore, with the superstructure of the road—that is, with the road material, or broken stone—after the surface of the ground or road-bed had been prepared for its reception. A partial section of MacAdam road is shown in Figs. 2 and 3 of Plate I., Vol. LIII., p. 238.

Fig. 2.

1st. *The broken stone, or "road metal."*—This was obtained, at first, entirely from the hard trap or basaltic boulders that were found profusely scattered over the Park grounds. The larger boulders were split into two or more parts by drilling and blasting, and these, together with the smaller sized boulders, were "sledged up" by hand, by the use of heavy hammers or sledges, the product being usually angular wedge-shaped pieces of stone, of six to twelve inches in their largest dimensions. These pieces were next broken up by the use of small stone hammers, weighing one and a quarter to one and a half pounds each, (Fig. 2,) into the sizes required for use on the road. The rule as to size was that commonly adopted—the stones to pass through a two and a half inch ring in their largest direction.

The boulder stones were peculiarly hard and tough, and difficult to break, especially in the sledging operation, without considerable practice and adroitness on the part of the men employed. Ordinary granite, gneiss or limestone breaks much more easily, but from this fact these kinds of stone are less serviceable for wear. The tenacious quality of the basaltic boulders gives them great superiority

over other kinds of stone, and this consideration, together with the advantage afforded of obtaining them near the site of the roads, rendered their selection for the intended purpose a question that admitted of no doubt.

A large quantity of broken stone of this description was prepared in advance of the other portions of the road work, several hundred men having been employed by the Park Commissioners for the purpose, previous to the commencement of the actual construction of the Park. After the roads had been commenced, it appearing that the boulder stone would not suffice for the completion of the roads, in case the MacAdam method was adopted throughout, (or even if the Telford method were in part substituted,) men were set to work breaking up stone from the gneiss rock of the Park that was blasted out in making the road excavations. This latter stone, being inferior to the boulder stone, was made use of by depositing it on the roads in the bottom portion of the layer, making about one-half of the full depth, and the balance was completed with the harder and superior boulder stone.

Fig. 3.

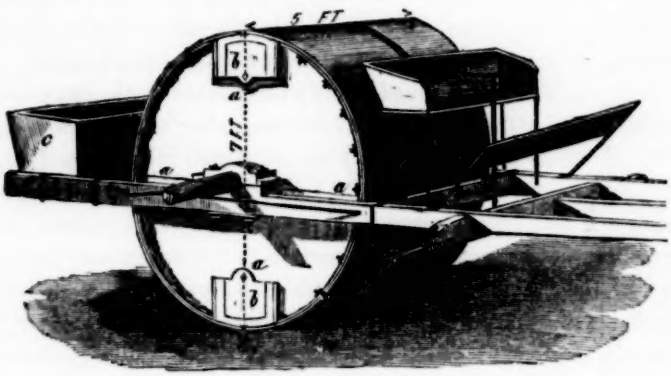
In placing the stones upon the road, care was taken to obtain them as clean and free from the finer or crushed particles as possible. Broad forks, or "pronged shovels" (Fig. 3), made for the purpose, were used in transferring the stone from the piles where they were broken to the carts that hauled them to the work; by this means the dirt and finer material were sifted out.

2d. *Manipulation of materials, rolling, &c.*—The full depth of the layer of broken stone, gneiss and boulder was twelve to thirteen inches, and was made up in successive layers of three to four inches thick. Each layer was evenly spread and rolled, and, as far as practicable, and time would permit, the benefit was obtained during the different stages of the work, of the travel of the working teams, wagons and carts of the Park over the stone, to aid in its consolidation. The rollers employed previous to depositing the last or surface layer of stone, were the same that were used in rolling the road-bed, and were drawn by two horses. These rollers were six feet long, composed of six cast iron cylinders, thirty-six inches in diameter, and weighed altogether about one and

three-quarter tons. Heavier rollers would have been liable to press the broken stones into the road-bed and disturb the foundation, especially if the rolling had been carried on after a rain that had softened the earth. Rolling was avoided, or was done with great care, when the materials or road-bed were too wet; when the stones were dry, water was applied by sprinkling. All inequalities of the surface of the several layers, caused by the travel of teams or by the process of rolling, were adjusted as they occurred, and the crowning form of the road was accurately preserved throughout, by men who were employed with the necessary implements, (chiefly iron rakes and pronged shovels,) and instructed for the purpose.

After depositing the last layer of hard stone, a heavier roller was used. This roller was constructed specially for the purpose, Fig. 4. Its weight was six and a half tons, and was adapted to being loaded

Fig. 4.



additionally, as required, to nine and twelve tons. It was composed of two hollow cylinders of cast iron, set abreast on a strong wrought iron axle, making together a length of five feet, with a diameter of seven feet; the cylinders were set in a timber frame-work, that was so arranged as to admit of being suitably balanced on the journals, and the whole was drawn by eight horses.

Apertures were made in the ends of the cylinders, through which the interior cavities, consisting of four separate cells in each cylinder, could be filled with broken stone and gravel, and the weight thereby increased up to twelve tons, as above stated.

Two of these large rollers were constructed at the commencement of the work, and have served, with but few repairs, for the

entire road system of the Park up to the present time, and are still in tolerably good condition.* They have performed, literally, a heavy duty, and it may be said to their credit, that the service they have rendered as road-makers have not been surpassed by those of any other *inanimate matter* that has been employed.

It may be added, that some study was given to the general plan and arrangement of these rollers, and it has not been discovered, during the period they have been in use, that any material modification of the design could be made to advantage. As will be seen hereafter, in the description of other kinds of road, they are adapted to the Telford and the gravel roads without additional loading, and when loaded, partially or to their full capacity, they are adapted to the greatest requirement of McAdam roads.

At the commencement of the MacAdam roads, the experiment was tried of rolling and compacting the stone by a strict adherence to MacAdam's theory—that of carefully excluding all dirt and foreign material from the stones, and trusting to the action of the roller and the travel of teams to accomplish the work of consolidation. The bottom layer of stone was sufficiently compacted in this way to form and retain, under the action of the rollers, (after the compression had reached about its practical limit,) an even and regular surface, but the top layer—with the use of the heavy roller, loaded to its greatest capacity—it was found impracticable to solidify and reduce to such a surface as would prevent the stones from loosening and being displaced by the action of wagon wheels and horses' feet. No amount of rolling was sufficient to produce a thorough binding effect upon the stones, or to cause such a mechanical union and adjustment of their sides and angles together as to enable them mutually to assist each other in resisting displacement. The rolling was persisted in, with the roller adjusted to different weights up to its maximum load, until it was apparent that the opposite effect from that intended was being produced. The stones became rounded by the excessive attrition they were subjected to, their more angular parts wearing away, and the weaker and smaller ones being crushed. The experiment was not pushed beyond this point. It was conclusively shown, that broken stones of the ordinary sizes, and of the very best quality for wear and durability, with the greatest care and attention to all

* They have received from the operatives at the Park the name of "Mammoth Rollers."

the necessary conditions of rolling and compression, would not consolidate in the effectual manner required for the surface of a road, *while entirely isolated from, and independent of, other substances.* The utmost efforts to compress and solidify them while in this condition, after a certain limit had been reached, were unavailing.

(To be continued.)

From the London Journal of the Society of Arts, No. 740.

(Continued from Vol. LIII., page 314.)

IRON PERMANENT WAYS IN USE ON GERMAN RAILWAYS.

Discussion which followed the reading of the paper reprinted as above.

Mr. Robert Mallett, F. R. S., said, with some of the details he was before acquainted, having himself seen the permanent way alluded to in Germany last year. He thought no doubt could be entertained, in the present day, that the epoch of timber sleepers was approaching its close, but the question arose what we were to substitute for them. There were two or three principles which were incontrovertible with regard to permanent way—one was that the nearer we approached to a lathe bed the nearer we were to perfection, but in a lathe bed we had a uniform load passing over it at a uniform speed, and a uniform support for the entire length; therefore we could afford to make the bed of perfect stiffness, and could maintain it true. A railway was placed under different circumstances. It could only be supported at intervals. For, even if it was a continuous iron way, resting upon continuous ballast, it was in fact only supported at intervals. If the table of the rail itself was of such a weight, and possessed such inertia that the load in passing over it caused concussion at the immediate attachment of the rails, it mattered not if the material of the ballast were india rubber, the result would be the destruction of the rolling-stock, in proportion to the inertia of the table it ran upon. They might mitigate this by springs as regarded the carriages, but they could put no springs between the wheels and the axles. Wheels of 4 feet, or 4 feet 6 inches in diameter, and often 2½-inch tires, with axles often 7 inches and seldom less than 4½ inches diameter, were in themselves prodigious hammering masses, and at high speed there was practically a succession of hammering blows. Take any point in the circumference of a wheel: that point described a cycloid, and at each moment of its touching the rail the tangent of the cycloid was perpendicular to the rail, and thus the point descended with a direct hammering blow, the effects of which were in proportion to the weight of the wheel and the velocity with which the point of the periphery

struck the rails. There was therefore a succession of blows, which they must mitigate as best they could. If they had an enormous inertia in the metallic parts of the rails, the result would be similar to that illustrated by Belzoni the traveler, who placed a heavy anvil on his chest, and allowed blacksmiths to strike it with hammers. This appeared to be a feat of marvelous strength, but so long as his ribs were strong enough to bear the weight of the anvil, the force of the blow was expended on the anvil itself, and the heavy permanent way did just the same thing. It therefore appeared to him that if they adopted iron sleepers they must arrange to make the bearing elastic in the same way, but how that was to be effected with these deep rails and double angle irons appeared to him a matter of some difficulty. There could be no question that an enormous advantage was gained by the substitution of steel for iron in the upper part of the rail. The London and North-Western Railway, which was considered as a pattern railway in respect of the large traffic and the regularity and rapidity with which it was carried, had substituted steel for wrought iron rails, without reduction in the weight of metal. They were not attempting to economize in the outlay for the substituted rails, but the economy was looked for in the greater resistance to wear and tear. He believed the experience of M. Rochussen with steel rails for the light traffic of the German lines had been different to that in this country generally. He apprehended the life of a steel rail, instead of being twenty-one years, would, on some parts of the London and North-Western, scarcely be as many months. At the same time, there was no doubt the steel rail was the right thing. If they got a material which did not hammer down, or laminate, as the surface of soft wrought iron did, there was the greater reason why, with an enormously rigid material like steel, they should have beneath it an elastic support. He only ventured to assert that as a principle, because if he went into particulars it would lead him to talk of himself as a permanent-way inventor, and he would be sorry to do that. He confessed he did not see that that was effectually done by these angle-irons. It was very similar to what our ingenious fellow-countryman, Mr. Bridges Adams, had patented; the main difference was that he turned the angle-irons the other way. It seemed to him, in the arrangement adopted on the German railways, there was a certain liability to become uneven. The steel top, which bore the load, itself rested upon the narrow edges of these two angle-irons. In all these systems the question was what amount of surface had they in the angle-iron to support the steel table above; because though the steel top might be permanent, it was doubtful whether the angle-iron might not give way at the point of contact with the steel top. He confessed that the bearing surface in the case before them appeared to him exceedingly small, and he apprehended some difficulty in that direction. But no man, not even the chairman, who was himself one of our most successful designers of rails, could predict beforehand what would be the results of the workings of any permanent way; nothing short of

actual trial under rolling loads would decide whether a permanent way would answer or not. He was far from attempting to dogmatise with respect to these German lines. The system might be found to answer there better than he expected; and his general observation of those lines showed that for the most part they had worked well.

Mr. Rochussen wished to speak with the highest respect of Mr. Adams' system, and he regretted that it had not been adopted in this country to the extent which he considered its merits deserved. The difference between the two systems was, that Mr. Adams' was a suspended rail, held with two angle-bars, in which the angle, instead of standing up, was hanging down. It would have been well to have had more experience of that system.

Mr. Varley remarked that a rigid permanent way appeared to be excellent to a certain extent, but that a due amount of elasticity in the bearings must be provided. It occurred to him that it would be well to ascertain positively the flexure of the rail, and then make it so convex as to keep it level by the weight. He had passed over the railway at Chat Moss, where the road was highly elastic, and it was the smoothest traveling he had ever experienced.

Mr. W. Botly said, mention having been made of the Bessemer cast steel, some few years ago it was considered a great triumph of science that steel could be produced in about two hours, which operation formerly took, on an average, about a fortnight. It had been stated in the paper that Bessemer steel was not so good as that which had been converted by the crucible process. He wished to know whether this was generally admitted. He apprehended that the welding of the harder material (steel) upon one of a more elastic nature (iron) furnished the conditions that were required for a permanent way. He begged to ask whether greater inconvenience, in respect of the wheels of the cars not biting the rails under certain circumstances, was experienced with steel rails than with iron rails.

Mr. Rochussen said no one was more convinced than he was of the merits of the Bessemer invention. But, on the other hand, he believed Mr. Bessemer himself would be the last to advance that his process could produce a metal which in every way equaled the old crucible cast steel. It was a method of converting cast iron into malleable iron, and then into steel, which had all the convenience of being cheap, and of enabling them to deal with large masses of material. That sytem had been worked as successfully in Prussia as in this country, and he believed the manufacturers of Prussian Bessemer steel had no reason to be ashamed of their production. He admitted that the "biting" of a wheel on a steel rail was less than that on an iron rail, but they found less inconvenience from that in Prussia, inasmuch as the weight of the rolling-stock upon the same wheel base was almost double that of the rolling-stock used in England. First-class carriages weighed from ten to eleven tons. The luggage trucks were of the capacity of ten tons each, and this remark would more or less meet the observation made by Mr. Mallet with reference to the

supposed light traffic on the Prussian railways as compared with this country. These rails had been laid down on the German lines for the most part where the traffic was exceedingly heavy, and where it was necessary to provide something more durable than the old system afforded. The duration of steel rails, which he had advanced as being twenty-one years, was proved by the steel rails laid down at the Hamm station in Westphalia, which might be regarded as a counterpart of the Crewe station in this country—not that the traffic was great, but it was the principal junction on the continent for the mineral and coal traffic; and when a discussion on steel rails took place at the Institution of Civil Engineers, he produced some rails which had been taken from that junction, where they had been in use twelve and a half years, after having sustained a traffic of fifty millions of tons of goods. Those rails, which were of the Vignoles form, had then only one side of the head slightly abraded; they were not in any way worn, and were fit to work for another five years at least, having the other side of the head untouched; those rails were only 56 lbs. to the yard, having been made at a time when engines weighing from 37 to 48 tons were not dreamt of, and when, if such engine had been in use, iron rails of 85 lbs. would have to be laid down. With regard to steel-headed as compared with solid steel rails, he would remark that it was the compound nature of the rail which formed the backbone of support to the load. As Mr. Mallet observed, they wanted elasticity; and how did they provide it in a steel rail? They could not weld the steel to iron upon that large scale; therefore, the steel was made to rest directly on the material which had the greatest affinity for it, viz: puddled steel, and below that they placed the most elastic fibrous iron that could be found. If, from motives of economy, they did not use cast steel for the head, they employed puddled steel, and fine grain iron for the web, such as was known in this country as the Low Moor, and again fibrous iron at the bottom. But in speaking of this kind of permanent way, regard must be had to the support it received from the ballast which, in the Prussian system, formed a most important portion of the line, for the work ordinarily thrown upon the sleepers was, in a great measure, done by the ballast, and by that means the violent concussions described by Mr. Mallet were avoided, the ballast in reality taking a large portion of the work of the line.

Mr. Juland Danvers wished to ask one or two questions, being interested in the construction of railways and public works in India. It seemed to be universally acknowledged by the preceding speakers that the use of wood for sleepers was condemned. He would be glad to know why that was the case? He saw in this country wooden sleepers almost universally adopted, and this was also the case on the Continent, except on some of the German lines. In America iron had been rarely introduced for sleepers, and yet it appeared that wood was now generally regarded by the profession as a failure. This was a very important question as regarded India, where timber was plentiful, but hitherto they had been unable to supply iron; all the iron

was obtained from Europe, and this increased very much the cost of of railways in India. Wood had certainly failed there as sleepers, and half the lines were constructed with the iron pot-sleepers. He was anxious to ascertain why, if good durable wood could be obtained, at a much cheaper cost than iron, it should not be made use of; and why, as a general rule, iron was so much preferred? He knew many instances in which iron had cracked, while wood often lasted a considerable time. A short time ago he was requested by the India Department of the Government to inquire into this question, and the conclusion which he reluctantly came to, after taking all the evidence he could collect, was, that unless a cheaper and more durable wood was obtained in India, it would be desirable to employ iron sleepers very generally in that country.

Mr. Mallet added, on the subject of wooden sleepers in America, that the abundance of that material put iron sleepers quite out of consideration. Wood was almost a drug, while iron was the most expensive material that could be employed in construction in that country. The railway system was begun there by using strips of wood with bar iron, little better than hoop iron, on the top; now they had iron rails, and by-and-bye they might get to iron sleepers. With respect to sleepers in India, hard wood was principally used for the purpose, and was said to be very durable, if protected from the attacks of the white ant; otherwise it was rapidly destroyed. In tropical climates, not of the arid nature of a large portion of India, such as Panama—wooden sleepers had disappeared in a remarkable manner very rapidly, though composed of very hard wood. Wood was an increasingly dear commodity in this country, and would not be obtained in sufficient quantity. He believed the chairman would confirm the statement, that in Russia oak sleepers were used almost entirely. [The Chairman said this was the case in Russia, wherever it was possible.] With reference to what had fallen from Mr. Rochussen, on the subject of the different qualities of steel for rails, he (Mr. Mallet) did not think it of much importance whether crucible steel or Bessemer steel were used. It was simply a popular error to suppose that Bessemer steel was worse for the purpose than the best cast steel made by cementation in a crucible. He had seen as good steel made by the Bessemer process as by that of cementation, but the commonest Bessemer steel could be made into good steel, possessing every necessary quality, by allowing the metal to remain in a melted state for some time in a reverberatory furnace. M. Sudré was the first to show that steel could be melted in a reverberatory furnace, and that if the mass of molten metal was covered by a coating of glass, of the quality of ordinary wine bottles, the steel was effectually protected thereby from the action of any sulphurous matter which might be contained in the fuel. Independently of that, however, a new process of steel manufacture had grown up since the introduction of the Bessemer process. It was found that very excellent steel might be made by melting down scrap iron in pots, which might be heated

twenty at a time in the Siemens furnace; and with the addition of spiegeleisen to the fused mass, and by stirring it up well, it was converted into steel. That process was now in operation by Mr. Siemens, and the result of his working was, that he could make a ton of steel with the consumption of a ton of coal; and he (Mr. Mallet) had no doubt that, though the Bessemer process would always be regarded as a grand revolution in the metallurgic art, the last process to which he had alluded had a vast future before it. The great advantage of it was, that old wrought iron rails might be cut up, melted, and reproduced as cast steel.

Mr. Livesey stated that on the London and North-Western Railway many thousands of tons of steel-headed rails had been laid down, consisting of Bessemer steel welded to the body of the ordinary rail; but between the Bessemer steel and the ordinary rail there was inserted a puddled bar of very soft iron, and by that means they got an almost perfect weld. He knew several railways in this country on which the old rails were being replaced with rails with Bessemer steel heads welded as he had described. He had reason to believe that the steel-headed rail would supersede the solid Bessemer steel rail. He had heard that in America the solid Bessemer steel rails had given way to a great extent in severe weather, and it was thought they would have to fall back upon the steel-headed rail in preference.

The Chairman said he would briefly express his own opinions on the subject, and in so doing he was sure Mr. Rochussen would pardon him if he differed from him in some of the points brought forward. Mr. Rochussen had proceeded, as far as he (the Chairman) understood, on the principle of making the bearing surface and rail as rigid as possible; but as far as his own experience went—and he believed it was that of most engineers—there should be, as Mr. Mallet said, some elastic substance interposed to guard the necessarily stiff rail from the impulsive action of the engine and train that run over it. Thirty years ago that was demonstrated almost to a certainty. The line between Manchester and Bolton was laid in the most rigid manner possible, the consequence of which was a continual fight between the railway and the locomotive, which thus became mutually destructive to each other. It was admitted that there must be elasticity, and the reason why there was the smooth motion over the line at Chat Moss, which had been mentioned, was because of the elastic base on which the rails were laid. Therefore he did not concur in the principle laid down by the author of the paper. He would not cavil at the multitude of parts constituting the permanent way, or at his ingenious contrivances for securing the rail, so as to diminish the expense of his system; but for his own part, he thought that this complication produced more harm ultimately than was counterbalanced by the saving of expensive material. He had yet to learn, and he feared Mr. Rochussen had not sufficiently considered, what would be the effect under severe traffic of the bearing of the steel rail-head upon the narrow supports. The last speaker alluded to what was going on on the

London and North-Western Railway; but perhaps he was not aware that for the last few years the specifications for the manufacture of rails had usually been that the hardest material should be put at the top, and the base should be formed of fibrous iron. The highest point of excellence at which that system had arrived was the substitution of steel for the top of the rail, and practically they had now the means of connecting the steel top with the base and sub-base of the rail by welding, in a manner more simple than that described in the paper, and without involving its many complications. With respect to the question which had been asked by Mr. Danvers, why wooden sleepers were to be abandoned, he (the Chairman) would say that his old-fashioned notions led him still to be an advocate for wooden sleepers. He thought when they looked in the first place at the admirable simplicity of a fished rail, without chairs, laid upon wooden sleepers, and considered the first cost of that system, and also of its periodical renewal, and when, in the second place, they calculated how much more capital had to be expended in laying down one of these expensive iron systems, they would find, spreading the cost over a number of years, that the wooden system was the more economical. He had found in South America, and especially in Bahia, a hard wood which resisted the white ant, provided it was cut at the proper season. He found that the cost of sleepers of that wood was very little more than the softer wood imported. With respect to India, he might state that twenty years ago he had the honor of reporting to the East India Company upon the introduction of railways in India, and he recommended at that time that the harder woods of the country should be employed as sleepers, because it was known that if certain hard woods were cut at the proper season, they would resist the white ant, and last for eight or ten years. Moreover, he had known creosoted timber to last for fifteen years without the least decay. He had tried the iron pot-sleepers; wherever there was sand and perfect drainage, these sleepers succeeded, as, for instance, in Egypt, but if the ballast was composed of broken stone or clay, they gave way. The Chairman concluded by proposing a cordial vote of thanks to Mr. Rochussen for his paper.

Mr. Rochussen said he had brought this paper before the Society simply as a record of what had been done in Germany. He confessed he thought, when he first saw some of these plans, they could not answer, but experience had shown that they were at least worthy of some consideration. The compound rail had been in use in Germany fifteen years, and it was found to be a step in advance, and upon that the systems he had just explained were in some respects founded. But perhaps they were more applicable to hot climates, where suitable wood for sleepers was difficult to be obtained. The system of steel making described by Mr. Mallet was not new in Germany, for a manufactory had been established in Westphalia which produced the same results, though by somewhat different means.

From the London Mechanics' Magazine, April, 1867.

THE SUEZ CANAL.

At a meeting of the Institution of Civil Engineers, held on Tuesday evening, Thomas Hawksley, Esq., Vice-President, in the chair, the paper was read on the Suez Canal, by Colonel Sir W. Denison, K. C. B., R. E., Assoc. Inst., C. E. It was stated that the scheme of the Suez Canal might be said to comprise two distinct undertakings. The first, and principal, was the construction and maintenance of a broad and deep water channel on one level, between Port Said on the Mediterranean, and Suez on the Red Sea. The second, preliminary in point of time, and indeed essential to the construction, as well as to the beneficial use of the canal, was the maintenance of a supply of fresh water sufficient for the wants of the population congregated along the line of canal, and especially at its two extremities. The arrangements for the last named undertaking had been completed, and were described. At Suez, a dry dock, capable of taking in the largest steamer, and an outer port, or basin, were in progress, but these were being carried out by a separate agency.

An account was then given of the character of the works of the salt-water canal, the course of which was traced, and of the state of the works when visited by the author, including the jetty, or breakwater, at Port Said, to protect that port against the action of the north-westerly or prevailing winds. The opinion arrived at by the author, based upon what he saw and heard during a visit to the canal, and upon a consideration of the correspondence between M. de Lesseps and the late Mr. R. Stephenson, and of the report of Mr. Hawkshaw, dated February, 1863, was—First, that (subject, of course, to the condition that the relative levels of the Red Sea and the Mediterranean were as stated by the French authorities) there would be no extraordinary difficulty in carrying an open salt-water channel from the Mediterranean to the Red Sea of the depth proposed, namely, 8 metres. Secondly, that no special difficulty in maintaining this channel need be anticipated. Thirdly, that it would he necessary to modify the action proposed by the French engineers, making the side slopes much more gradual. And fourthly, that the cost of the above-mentioned depth of water would be found at first to be largely in excess of the amount estimated. Eventually, it was by no means impossible that means might be taken to fix or check the drift of sand, or to shut it out from the canal. But for some years it must be expected that the ordinary action of the atmosphere, which had filled up former excavations made in this dry desert, would have the same effect in the new canal. Looking at the work as an engineer, there did not appear to be any difficulty which a skillful application of capital might not overcome.

Mechanics, Physics and Chemistry.

(Continued from Vol. LIII., page 403.)

LECTURES ON VENTILATION.

Delivered before the Franklin Institute, by L. W. Leeds, Esq.

LECTURE III.

At the first lecture, I endeavored to show how much we were suffering from the effects of foul air, and the advantage to be gained by supplying ourselves all the time with pure air. Because we must first feel that there is something to be gained before we will make any great effort towards obtaining a given result.

At the second lecture we considered the general principles governing the circulation of air, the courses of its movements, the manner of the action of heat upon different kinds of substances, which creates a constant, ceaseless motion of the air, in all places, from the minutest corked bottle to the vast currents that sweep over the face of the earth.

Now, having learned the necessity for pure, fresh air, and studied the general laws governing its circulation, let us apply these principles to every-day life. To every-*day* life? I should say every-*hour* life—nay, every *moment* of our lives; for twenty times every minute of our entire life, from the cradle to the grave, do we breathe what ought to be pure air. Is it always pure?

If we breathe one single breath, the entire day, of *impure* air, it will weaken us, deduct from our capacity to attend to our daily duties, and shorten our lives, in exact mathematical proportion to the amount of impurity in that one single breath. Now, we breathe twenty times every minute, twelve hundred times every hour, twenty-eight thousand times every day, and nothing but absolute and perfectly pure air answers the exact requirements of perfect health.

Well, you may ask, at first thought, if fresh air is such a panacea for all evils, and there is such an abundance of it out of doors, why not breathe it, and always enjoy perfect health?

Think one moment. I eat my breakfast in the morning, generally refreshed by a night of good sound sleep, (for I sleep with my windows open.) Immediately after breakfast, I enter the cars to come to the city. What a smell comes from the car as the door is opened! and unless I wish to incur the displeasure, or provoke the indignation, of

almost every passenger, by opening a window, I am obliged to sit in that foul, offensive atmosphere, and breathe the poisonous exhalations from my own lungs, and that from dozens of others, some of them, it may be, badly diseased, (most persons' lungs *are diseased* in this country, from breathing foul air, and many other diseases besides consumption are produced thereby.)

Thus, in one half hour, I have inhaled six hundred times of this foul and poisonous air, and the blood has carried it to every portion of my body, so that my entire system is completely saturated, poisoned, yes, thoroughly poisoned by it, from the crown of my head to the soles of my feet.

And thus is the day commenced. Your blood is thoroughly poisoned before your breakfast is digested; for your breakfast will no more digest without pure air than the coal in your stove will burn without it. You are subjected to headache, dyspepsia, and a half dozen other aches and pains, and are tired out long before night. And thus you are killed long before you would die if you breathed pure air only.

And am I relieved from the difficulty when I arrive in the city?

Start to-morrow morning at the Delaware River, on Arch or Walnut Streets, or any other street, and go to the Schuylkill. Inquire of every individual, in office, store, dwelling or factory, if he knows whether he had pure air to breathe all day, or whether he can tell you, with any degree of accuracy, how pure the air was in the room he occupied for any hour of this day.

I fully believe there is not one in ten—no, not one in a hundred—of the most intelligent men in that entire street, doctor, lawyer, architect, or any other, that can give you an accurate account of the condition of the air breathed during any one hour of the day. That is not all. There is scarcely one in a hundred that can satisfy you, by an intelligent description, of the means used for providing it.

First—Assuming the air outside to be pure, that there was a constant, positive and sufficient supply of that outside air introduced.

Secondly—That that pure air was not deteriorated by overheating, or contaminated by being mixed with the poisonous gases of the burning coal.

Thirdly—That there was sufficient moisture added to it to compensate for its increased capacity for moisture, due to its expansion by the additional heat given to it, (which is a very important thing.)

Fourthly—That there was any accurate, positive means provided

for insuring the fresh air to be brought within reach of the lungs of those for whom it was intended.

And, lastly—That there was a positive means provided for the removal of all the poisoned air thrown from the lungs, so that none could possibly be *re-breathed.*

No; you will find them in close, unventilated offices, in close factories, in almost *air-tight* dwellings. In the large stores they do better.

The air is very commonly overheated, it is often mixed with impurities, and very seldom supplied with a proper amount of additional moisture.

The air is often so dry, that in a few minutes' conversation the linings of the air-passages to your lungs become parched and husky, producing irritation and a feverish condition of the system. And even in this room, to-night, do you see any opening at your feet, connected with a heated flue, for drawing the foul air from the floor as fast as thrown from your lungs? I believe there is not a square inch provided for that purpose.

Or, do you see any escape immediately above the gas-lights, for carrying off the burned air while hot enough to escape? Not one. There are two or three openings, I think, on the back part of the room, just at the ceiling, but for your breath to get there, it must rise and pass by the zone of respiration, and much of it be again re-breathed; and the products of combustion, as we have seen, would cool sufficiently to fall to the floor long before they reached that point.

I take the liberty of calling your attention to this with more freedom, because it does not indicate any special inattention on the part of the Managers. It is not an exceptional case, but it is the rule. It is the popular opinion of the proper means of ventilation.

Go with me, if you please, to that magnificent building, completed but a few years since, at a cost of half a million of dollars, and given by its noble and generous founder to the city of New York. You will notice, inscribed above the entrance, cut in the solid stone, "To the Arts and Sciences." Look in this reading-room—perhaps the most useful and most appreciated of any public reading-room in the United States. See the large numbers of honest, industrious mechanics, snatching an hour from their labors, to look over the current literature of the day. Here, certainly, we shall find the most perfect arrangement for heating and ventilation that our knowledge of the

arts and sciences could suggest. Let us see the arrangements for bringing in the fresh air, for warming it in cold weather, and removing the foul air.

What! no provision for a regular supply of fresh air? Not one foot, not one inch—neither are there any regular flues for the removal of the foul air. And this most remarkable condition of things is but repeated in the magnificent hotels, marble palaces used as offices, and in many of the new and splendid colleges; and, we might almost say, in all other buildings throughout the length and breadth of our land.

Thus you see how difficult it is for one to mingle freely in the society of his fellow-men, under existing circumstances, without being subjected to being poisoned by foul air. In going from here to my home, to-night, I shall have to ride in those cars, the air of which I dread more than I ever dreaded the small-pox or cholera. I have been in hospitals where I have seen much of both. They may slay their thousands, but foul air its tens of thousands. And it is only when I get to my room, where I shall probably sleep to-night with two windows well open, allowing the unobstructed breezes of half a mile of open country to sweep through my chamber, that I shall feel entirely secure from the contaminating influences of foul air, and enjoy to its full extent the greatest of God's temporal blessings to man—*pure air.*

I have no new patent idea to present to you, which shall secure to you at all times perfectly pure air, without any further trouble on your part. There are no two constitutions precisely alike, any more than there are two human faces, or two handwritings, and there are no two hours in our entire life in which all the physical conditions of our body are precisely the same. It would be just as absurd, therefore, to go to a ventilating establishment, and tell the proprietor to ventilate your house or office, and pay the bill when it came in, and content yourself by saying: "Well, I am glad this ventilating business is done with. I have got my house ventilated, and the bills paid, and I am glad I am *through* with that vexatious business." I say this would be just as absurd as it would be, in case you had some pain or ache, to go to your doctor and get some medicine, and therewith content yourself, and say: "Well, I am glad this doctoring business is over with; I have been dreading it all my life. I have been to the doctor's at last, have been doctored, and got my medicine and paid my bill, and so I am through with that vexatious business."

No—you must first feel that fresh air is worth taking some trouble to obtain. You must then make it a *study how* to obtain it without *chilling* or *overheating* your body, in winter and in summer, at night and in the day time, when you are lying down and when you are sitting up, before eating and after eating, before exercising, while exercising, and after exercising—when you are well and when you are sick, when you are alone and when you are in the crowded cars, or in a crowded room, in wet weather and in dry, and for the ever varying changes of the external atmosphere—all these conditions require separate and intelligent thought.

In summer we depend almost exclusively on the natural movements of the air. To cause the air to *move* is then the great matter. We must then remember that the great masses of air move horizontally, not perpendicularly. Of course, there are many little disturbing influences, but I mean the great mass of the air moves over the surface of the earth in horizontal strata. You can see this by the smoke of the locomotive on the prairie, which can be seen sometimes for twenty or thirty miles, stretching along just above the horizon. All *flues*, therefore, are of little account in summer. We must depend on open doors and windows. Suppose you wish to ventilate your room in the morning, the air outside having become a little warmer than the air inside, and the upper parts of the window only lowered: the warmer air would flow across the top of the room, leaving the air undisturbed in the lower and colder part. In this case, the window should be raised from the bottom, or a door opened that would afford an escape for the air.

But again, suppose this same room to want ventilating in the evening. The room has become warm through the day, and the outside evening air is cooler than the room, and then, if you raise the windows from the bottom only, the cooler air will flow across the bottom of the room, leaving the upper part undisturbed and foul.

No doubt you have all noticed, frequently, that in going into a room in the evening, when your heads were above the window opening, it would be quite hot, but if you stooped down below the line of the open window, it would be cool and pleasant. All windows should be made to lower from the top, to meet this special case. If you are boarding, or are so unfortunate as to be put in a room where the great blunder has been made of not having the windows to lower, go to the nearest carpenter shop next morning, before breakfast, and get a chisel, and cut six or eight inches off of the little strip which

supports the sash, and, with a gimlet, bore a hole directly through the sash, on both sides, and with a nail you can keep the sash up in its place, when necessary. I have had hundreds, yes, I suppose, thousands, made to lower this way in the hospitals.

Motion, motion is the great desideratum in summer. You have all noticed, no doubt, how pleasant it is to go into a cool room, like a parlor, that has been kept shut up on a hot summer's day; but in a short time it begins to feel oppressive, and it is more comfortable to have the windows open, and a *circulation* of air, even if it should be a little hotter than the stagnant cool air.

Never sleep with closed windows in summer. It is in winter, however, that the greatest care is required in providing a constant supply of pure air. If we would but accustom our minds to comprehend, readily and quickly, that cold air falls and warm air rises, it would assist us in our conclusions. We all know that, of course, but we do not practice *applying* it readily and quickly on all occasions.

(To be continued.)

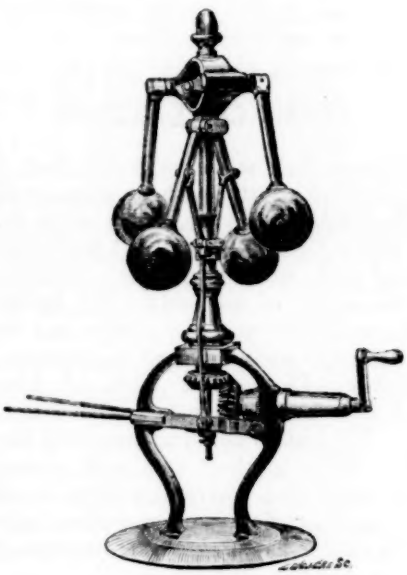
From the London Mechanics' Magazine, April, 1867.

COMPRESSED GUN COTTON.

WHILST the application of gun-cotton as an explosive agent has been steadily advancing, Messrs. Prentice & Co., of Stowmarket, the manufacturers of this material, have carefully watched the results of its mechanical work, as well as the chemical investigation to which it has been subjected. We have now pleasure in calling attention to their recent improvements, in which, applying the system of Professor Abel, chemist to the War Department, they are enabled to carry out a plan of compression which their experience has led them to see is of value in the use of this material. The principle thus introduced insures the most perfect attainment of the points essential for the safety and stability of the material, and, it is stated, renders it non-explosive in the open air, at the same time securing the highest effective power. In preparing this material, the cotton is first made explosive in the usual manner, then taken to the pulping mill under Professor Abel's system. After thorough separation of the fibre and admixture of the pulp, it is compressed by hydraulic machinery, until one inch of the cotton of any given diameter is equal to six inches of powder. It is in a most portable and convenient form, and the advantages to the miner of having the whole of his explosive force confined at the bottom of the hole cannot be over estimated. The new process of manufacture will no doubt give results which will materially lessen the work of miners, quarrymen and contractors.

THE SHIVE GOVERNOR.

We insert below a letter received from Mr. Shive, premising that the manner of testing and comparing governors referred to, is shown in the accompanying cut, where two forms are given, attached to the same spindle, and receiving, therefore, of necessity, the same speed of rotation from the driving gear operated by the handle to the right.



N. W. Cor. Twelfth and Buttonwood Sts.,
June 1st, 1867.

Prof. Morton.

Dear Sir: It appears that certain parties have objected to my manner of testing and comparing the action of governors. I should be pleased to meet them in test, on any arrangement they may suggest, everything being equal except construction. The higher the ball is forced to carry, and the further the joint from the centre in the radial, the more I gain over it. At ordinary speed, I have power and action over it as ten to one; this proportion I increase as the increase of the speed.

It is not generally understood, even by those that build such governors, why they swing balls in planes approaching the horizontal. They find that such governors are more steady on the engine, the

reason for which is plain. The radially swinging ball cannot act till the proper time has passed, and then always acts with a plunge. The lower such ball swings, the greater the range of the plungers; so the speed is carried to extremes, till the ball rises into planes where the force exerted is nearly longitudinally with the arm, and the vibrations are forced into narrow limits, and the plunge shortened in proportion. But what a make-shift, for a machine so important as a steam-engine governor.

Respectfully yours,

D. SHIVE.

From the London Engineering, No 69.

CHAIN CABLE TESTING.

WE some time since drew attention to the fact that cables which have borne the Admiralty test, and have been certified by the Board of Trade, are frequently breaking, much more frequently, indeed, than before the Chain Cables Act of 1864 made the test compulsory. The test is a dead pull, equal to 11¼ tons nearly (11·46 tons) per square inch of the section of the cable. We know of several firms, the cables of whose ships have frequently and unexpectedly given way since this test was enforced, and it appears that other firms, among them Messrs. Lamport & Holt, of Liverpool, and Mr. J. G. Lawrie, of Glasgow, have memorialized the Board of Trade upon the subject. The first-named firm had seven cases of the breaking of newly certified cables in their own ships since November, 1865, and Mr. Lawrie states that where one cable broke before the Act ten break now. In some of these cases, and we know of others of the same character, the cable has broken the first time the anchor was let go, and when there was but little strain on.

A strong feeling has arisen that there should be no compulsory test at all, and Mr. Galloway, the Board of Trade surveyor, maintained this opinion in a paper which he read, the other evening, at the Society of Arts. This feeling is founded upon the conviction that, unlike tests of gold or silver, no testing of a chain cable, which is to be afterwards used, will disclose its real quality. It may be said that the present test is too severe, and for the general run of irons no doubt it is. But all the Admiralty cables are tested to the same strain; and made as they are of excellent iron, it is well known that they very seldom fail. If, too, the compulsory test were lowered in respect of the strain applied, many chain-cable makers, caring only to get their work passed, would merely use cheaper iron, which would just go through the proving-house without actual failure. The question is one more of morals than of mechanics, and it has little to do with "co-efficients," "dynamic value," "limits of elasticity," or other conditions within the domain of science.

While acknowledging the laudable objects which Mr. Laird had in view, we see that his Act is a failure, and must be either amended or repealed. Government does not enforce tests of railway materials, nor tests of steam-boilers, of which thousands upon thousands are working all over the kingdom and in British ships in every sea, nor tests of any other of the fittings of ships than their chains and anchors. Why make these exceptions to everything else? True, we prove gun-barrels, and we have a test for gold and silver. But we have reason for testing (if the test be a proper one) the strength of materials as applied for special and important purposes. Although government does not enforce tests of railway materials, for example, railway engineers find it important to test them, and tests are provided for in many specifications for rails. It happens, too, that the only lines on which locomotive boilers never explode are those on which both new and old boilers are tested, and periodically, to one-half more than their working pressure. Those of our readers who know the lines upon which no hydraulic test pressure is permitted, and who note where the locomotive boiler explosions of which they read, now and then, in the papers, occur, will not need to be told that they happen almost invariably upon these very lines. And if certain locomotive engineers refuse to test their boilers to one-half more than the ordinary working pressure, what would they say of the recommendation (expressed as a rule) of Professor Rankine, to the effect that they should be tested to *four* times their working pressure (!)—a pressure which would simply burst them, one after the other, as they were brought under the force-pump? It is but just, however, to the Professor to state, that he considers that no boiler should be worked to more than one-eighth its bursting pressure, and that the test strain, therefore, should be one-half the bursting pressure. In point of fact, it is not unlikely that, even where the test pressure is but one-half greater than that at which the boiler is to be worked, twice the test pressure would burst it, the factor of safety being not 8, but about 3, or possibly 4.

In the case of ordinary fixed boilers, experience has fully shown that it is to the interest of the owners and of the public that they be periodically tested as well as examined, and this is now largely done under a system of voluntary boiler inspection. Ship-owners, however, have never, as a body, shown any desire to have their chain cables tested, and have generally preferred to buy in moderately cheap, if not the cheapest, markets. They cannot test their cables for themselves, even if they knew what test to apply, without a comparatively costly apparatus, and, were they left to themselves, they would probably never test at all, because of the expense, and from a fear that the very act of testing would injure or destroy the cables.

Of those who thought at all upon the subject, there were few, with the exception, perhaps, of certain ship-owners and chain-cable manufacturers, who did not cordially agree with Mr. Laird in his view of the necessity for a protective test; but now that it is proved that the

present test is in many cases of but little real value, while in many others it increases the absolute danger of the failure of cables, it is important to devise a test that will really secure the protection of life and property without doing injustice to the ship-owner or cable maker. The object is, without injuring, much less destroying, the cable, to establish its good quality in respect both of material and workmanship. We have already said that, if the cable is to be put in use, it cannot be fully tested; for no test is sufficient which is not *à l' outrance*, or to destruction. It is impossible in tests of this character to test anything intended for further use, and hence the test is only inferential; that is, it having taken a severe test to destroy one chain, others submitted at the same time, and from which the trial chain *might* by accident have been taken, are presumably good. Now, we would recommend not only that chain cables should be tested, and that under a compulsory Act, (because they would never be tested otherwise,) but that the test should be, first, that of a direct tensile breaking strain of 25 tons per square inch of any link taken at random from one hundred links; and, second, that the cable should, as a whole, bear the Admiralty test of 630 lb. per circular eighth of an inch, equal to 11·46 tons per square inch of pulled section. The double test would add a little to the total cost of testing, and, what would probably arouse greater opposition, it would add heavily to the cost of cables themselves, by requiring a better quality of iron. Engineers might easily, and with much justice, ask for further tests, viz: that of working under the hammer, and that of elongation up to fracture, taking into account the appearance of the fracture, &c. But any tests depending upon the special knowledge or skill of the officer making the test would always be open to grave suspicion, as, for example, that a cold short crystalline figure might, for 5*l.*, be considered to show a fine fibrous tough iron. As for elongation up to fracture, a true engineer would ascertain it and be guided by it, but it would be idle to expect a staff of official conductors of tests to accurately make and report such indications of quality.

In any case, however, we have evidence sufficient to show that the Chain Cables and Anchors Act of 1864 must be either amended or repealed.

From the London Engineering, No. 70.

CREOSOTE AS FUEL.

WONDERS will never cease. Here is "creosote," as coal tar is elegantly termed, because it happens to contain a certain quantity of carbonic acid. The staff is worth, say, 20*s.* a ton. Now, if Mr. Charles J. Richardson's experiments are to be trusted, he has burnt creosote under his "petroleum" boiler with an evaporation of 18·91 lbs. (or nearly two gallons) of water per pound of the fuel consumed.

This rate of evaporation is twice that from the best coal, and about three times what is ordinarily gained. We are as unbelieving as most others, but why should not creosote beat coal as fuel? Taking the pure creosote of chemistry, it consists of $C_{26}H_{16}O_4$, whereas coal, were it a chemical compound, and were there a formula of it, would be more like $C_{88}H_5O_7$. The creosote contains a great proportion of hydrogen, each ton of which gives off three times as much heat, nearly, when burnt, as a ton of carbon—at any rate, hydrogen combines with exactly three times as much oxygen in burning. The wits of our gas engineers (some of them *have* used coal-tar fires though, but in a clumsy way) have never discovered how to extract the calorific virtues from creosote, and they have got rid of it to the railway people, who have pickled their sleepers with it, although some of them (and they are tremendously sharp fellows at calculating compound interest)—some of them, we say, and Mr. Crosley, of the Midland Railway, is one of them, have found that taking the compound interest upon the cost of creosoting, it does not pay in the long run. It is better to let the sleepers rot out a few years earlier, and to renew them. But we are digressing. We have called the stuff "creosote," because everybody appears to have settled the spelling that way. It should really be called cre*a*sote, from the Greek, Κρεας, flesh; σωζω, I preserve. In the meantime, we shall keep an eye on Mr. Richardson, the plucky architect, who has stuck to the petroleum, or rather liquid fuel, question like a brick to Portland cement. He is about to begin further experiments at Woolwich. The authorities tried to beat him at first; now they are doing all they can to help him. He burns coal-tar, shale oil and all the stinking liquid hydro-carbons known, along with superheated steam and hot air. Z. C.

A COMBINED COUNTERPOISE AND REVERSING APPARATUS FOR MERIDIAN INSTRUMENTS.

By Wm. M. Davis, Superintendent of Cincinnati Observatory.

Every improvement in the construction of instruments of observation which adds to their convenience or accuracy, is considered a benefit to the cause of science.

The following method of combining the counterpoise and reversing apparatus of a meridian transit, is supposed to be of that class; hence it is offered to the consideration of the astronomical public.

This single apparatus is designed to take the place of two separate devices now in use in astronomical observatories, viz: the counterpoise for relieving the Y's from excessive pressure, and the reversing car.

The peculiar mechanism by which this object is attained will be understood by the aid of the annexed diagram.

In Fig. 1, A represents the instrument, *a a'* the pivots, *b b'* the Y's, C C' the piers. D is a balance beam or lever of iron attached to to the pier, C, by an iron support, D, and is loaded at is outer end by the counterpoise, E, which is secured to the desired point on the bar by the set-screw, F. This weight is so adjusted on the lever as to nearly counterbalance the telescope and its accessories, leaving sufficient weight only on the Y's to keep the pivots in contact with them.

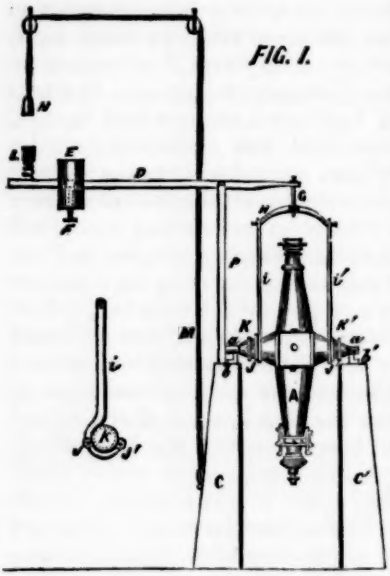


FIG. 1.

The instrument is suspended from the short arm of the lever by the following arrangement:

G is a steel rod, depending upon the lever, D.

H is a swivel-bar, supported by a head and collar on the lower end of G, and is capable of turning freely in an horizontal plane around said bar, and oscillating vertically on it, so as to allow equal pressure upon each of the Y's. The swivel-bar and the end of the lever immediately above it are made as thin as is consistent with the necessary strength of the parts, in order to obstruct as little light as possible from stars near the zenith.

From the ends of the swivel-bar, H, depend two hangers, *i i'*, each of which carries at its lower end a pair of friction rollers, J J', which, occupying grooved collars on the axis of the instrument, allow it free motion in a vertical plane. The hangers, *i i'*, are adjustable on the swivel-bar, so that equal portions of the unbalanced weight of the instrument may be made to rest on each of the Y's.

The auxiliary weight, N, is used only to reverse the instrument. The cord, M, which supports it, passes over pulleys attached to the ceiling of the room, the other end being secured, not to the pier, as represented in the drawing, but to a post secured to the floor, convenient to the observer.

To reverse the axis of the instrument, the tube is brought to a

vertical position, and the cord detached from its fastening to allow the weight, N, to descend into the cup, L, when the instrument is gradually lifted out of the Y's; then, if the observer be above, observing the mercury collimator for errors of level and collimation, he can take hold of the hangers and swing the axis of the instrument around with the greatest ease; or, if below, he can grasp the tube in his hands and reverse the axis with equal facility.

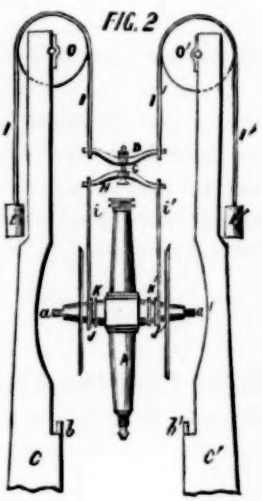
Now, by drawing gently on the cord, he brings the pivots again into the Y's. Then the weight, N, is lifted out of the cup to cut off contact between the building and pier.

Such is the plan I have successfully used during the last three years at this Observatory.

Its simplicity and convenience render it well adapted to instruments without circles, but for instruments with large circles, the lever would become inconveniently long; hence, a different mechanical arrangement to support the swivel-bar, H, seems to be necessary.

To accomplish this end, many plans have suggested themselves, the leading features of one of which I will venture briefly to explain.

Let the curved bar, D, in Fig. 2, perform the duty of the balance beam. In form and size it should correspond very nearly to the swivel-bar, H, and be placed parallel to it. These two are connected by the rod, G, which should revolve freely, yet closely, in the bar, D. This bar, D, is supported at each end by metallic bands or chains, which pass over large pulleys attached to the piers, which are extended upward for that purpose, as shown in the drawing. To the other end of these bands are attached the counterpoises, EE′, to save the pivots from unnecessary wear. In the foundation for the piers there should be built a recess to receive the machinery to operate a couple of chains, which are to perform the duty of the auxiliary weight described in the first form of the apparatus. These chains should be light, yet strong enough to perform the function allotted to them.



They are to be attached—one to the bottom of each counterpoise,

passing thence vertically down—either through or outside the piers, to two grooved pulleys in the recess below. The circumference of these pulleys should be greater than the greatest height to which the telescope is ever to be raised. They are to be secured to a horizontal shaft, and so placed that the vertical chains shall each form a tangent to the groove of the corresponding pulley.

Now, if the chains be attached to the pulleys where they touch them, and the shaft be revolved through a small angle, so as to raise the lower ends of the chains an inch or so, then there will be no strain on the counterpoises except the weight of so much of the chains as are not supported by the pulleys.

If, now, the shaft be revolved in the opposite direction, the chains will act simultaneously on the counterpoises, forcing them downward, and thus lift the telescope from the Y's without sensibly tilting the bar D. In this position, it may be easily reversed and safely replaced on the Y's. The shaft should be provided with the necessary stops to prevent it from revolving too far in either direction.

A very simple contrivance will give the observer complete control over the motions of this shaft, and thus enable him to raise the instrument, reverse it, and return it in safety to the Y's again, even without the aid of an assistant, should it be necessary.

Although the last modification of the apparatus has not been practically tested, I should not hesitate to use it should occasion require the mounting of a large instrument.

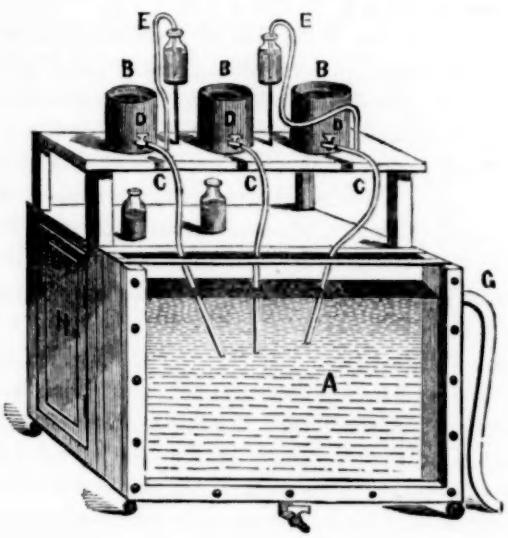
I can see no disadvantage which could attend its employment, except that the swivel-bar and its support will intercept a portion of the light from stars near the zenith. If properly constructed, they will not arrest more than six or seven per cent. of those rays, which will produce no inconvenience whatever, unless it be necessary to determine the magnitude of stars in that zone.

GLASS TANK AND ATTACHMENTS FOR EXHIBITION OF CHEMICAL EXPERIMENTS.

By Prof. A. R. Leeds.

In the exhibition of the action and character of metallic precipitates, in a popular lecture, delivered in the evening, the lecturer has to contend, especially, against the following three difficulties: In

the first place, the light which is afforded by burning gas has so decided a tinge of yellow as to falsify, to a considerable extent, the color of the precipitates. It is, moreover, diffused throughout the room, and does not fall with sufficient brightness to impart to the reactions which are taking place in the test-glasses a brilliant and striking character. And, what is of more practical importance than the preceding considerations is, that the precipitates, as ordinarily formed, fall in mass, and many changes of form and color, which are evident on a close inspection, cannot be perceived by the audience at large. It happens, from these causes, that there is no class of lecture-table experiments which are more apt to disappoint the expectations of both speaker and hearer than those which are designed to exhibit the presence of the various metallic bodies by means of test liquids.



To remedy these difficulties, the tank which is described below was devised, and employed in a lecture which was delivered upon the chemistry of the metals, at the Franklin Institute, on the evening of the 19th of February, in the present year.

It consists of—1st, the tank; 2dly, of the contrivance employed for illumination; 3dly, of the apparatus which is used to introduce and remove the solutions from the tank.

The tank itself, represented at A, consists of two parallel sheets of plate or common glass, which are placed about one-third of an inch apart, and in dimensions are about fifteen inches high by twenty inches in width. They are fastened together by a groove of tin, passing around the bottom and two sides, and into which they are cemented water-tight by means of red lead. As these arrangements impart a rather unsightly character to the tank, they are afterwards concealed from view by a frame, like that which surrounds an ordinary picture. The tank is altogether separate from the other parts, and is fastened in position by a ledge, upon which it rests at the bottom, and by hooks placed at the sides. The tank is emptied by a stop-cock at the bottom of A; G is a large overflow, capable of running off any surplus that might accumulate in case all three of the entrance-tubes were supplying the tank. A slit, of the breadth and width of the tank, is cut in the frame at the top.

2d. The tank forms the front side of a chamber, about a foot in depth, which is painted or papered white, and is furnished with a door at H. When in use, this door is opened until it comes into a line with the face of the tank, and then, behind it, but in such a position that no direct rays may enter the eyes of the audience, the cylinder of the lime light is placed. By this arrangement, the room is left in darkness, and all the light which proceeds from the ignited cylinder of lime is reflected from the white walls of the chamber, and in its passage through the tank is made to illuminate whatever body is present there, with great brilliancy.

3d. The tank is filled from the reservoirs, B, which are made of japanned tin, and of a half-gallon capacity, and which are furnished with stop-cocks, D. A short tube of brass is fastened into the upper side of the tubes of the stop-cocks of the two lateral reservoirs, in front of the stop-cocks themselves. All three are furnished with india rubber tubes, and these are made to terminate in glass tubes. In this way the solution may be made to enter the tank at any point, and by altering the orifices of the tubes, in jets of any form. The middle reservoir is used for filling the tank with water, and for washing it out. The lateral reservoirs are employed for introducing the two solutions which are to be tested. They do not contain these solutions, but the water which is in them, supplies the motive power needed to introduce any number of metallic solutions. This is accomplished by the following contrivance. The liquids to be tested are placed upon light supports, which are made of such a height that the bottom of the

bottles containing them shall be above the highest level of the water in the reservoirs. An india rubber syphon is fastened to the short tubes alluded to above, as being fastened to the upper sides of the tubes of the stop-cocks of the lateral reservoirs, and bending over dips down to the bottom of the bottles.

The stop-cocks of the end reservoirs being turned on, water flows into the tank; upon turning them off, the tube, c, being filled with water, and communicating with the bottles only, becomes the longer limb of a syphon, and draws the solutions over into the tank. Or, if it be not desired to perform the action rapidly, the stop-cock may be only partially closed, and then part water and part solution enter the tank. If it is needful to wash out the tubes before proceeding to a second precipitation, this may be accomplished either by placing bottles filled with pure water upon the supports, or, more simply, by allowing the syphon tubes to dip into the upper surface of the water in the lateral reservoirs themselves. Then the water which has issued from the bottom of the reservoir becomes a motive power to draw water from the top. The open space which is left between the top of the illuminating chamber and the shelf supporting the reservoirs, is for holding in their order the test liquids to be used. It is better for two persons to manage the tank—one to control the middle and another reservoir, and the other the remaining reservoir and the lime light. It is oftentimes desirable to turn the light down while the tank is being emptied, cleansed and filled again, inasmuch as the light which passes through the tank, either when empty or when it contains pure water, is too brilliant to be pleasant. At other times it illuminates the precipitates in an ever-varying and striking manner. At times, a tree sending off branches of dark green foliage; then a crimson fountain, and again, rolling and heavy clouds make their appearance. As yet, no stoppage, or trouble of any kind, has attended the exhibition of precipitates with a tank of this description. Among many reactions which are beautiful, the following deserve especial mention:

1. Between Acetate of Lead and Bichromate of Potash.
2. Sulphate of Copper and Ammonia and excess of Ammonia.
3. Sulphate of Copper and Ferrocyanide of Potassium.
4. Nitrate of Silver and Bichromate of Potash.
5. Tincture of Galls and Persulphate of Iron.
6. Persulphate of Iron and Ferrocyanide of Potassium.
7. Persulphate of Iron and Sulphocyanide of Potassium.

EDUCATIONAL

(Continued from Vol. LIII., page 414.)

LECTURES ON ELECTRICITY AND LIGHT.

Delivered before the Franklin Institute, by PROF. HENRY MORTON, PH.D.

AT the conclusion of our last abstract, we had described the "hydro electric machine," and, with this, might well conclude all reference to direct means of developing statical electricity. But though the means before mentioned include all that are practically applied, and usually employed for the direct development of this agent, there are others which, as a matter of curiosity and for the thorough treatment of our subject, it may be well to notice. We may state, generally, that any disturbance of molecular arrangement gives origin to electric excitement; although it may be difficult to follow up and obtain possession of the power set free, we can in most instances get good evidence of its presence. Among the actions by which this molecular friction and excitement is produced, may be enumerated, 1st. Pressure—This may be illustrated by placing a sheet of some soft body, such, for example, as india rubber, on the plate of a delicate electroscope, and compressing it with some insulated body. The motion of the electroscope will then indicate the presence of electricity. A crystal of iceland spar, if simply pinched between the fingers, will exhibit the same action, and will even retain the excitement so developed for a long time, in dry air. Thus, Haüy, who discovered this fact, found that a crystal of iceland spar thus excited will remain charged for as much as eleven days, and he even formed a delicate electroscope, by mounting a rhomb of this mineral on a balanced needle, which being positively charged, indicated at once, by its attraction or repulsion, the nature of the excitement presented to it. Beside the mineral just named, we find a like property in the Brazilian topaz, fluor spar, corundum, emerald, arragonite, rock crystal, the diamond, &c., though the duration in these is limited to a time, varying from many hours in the first to a few minutes in the last. It is worthy of note that the Iceland spar and the arragonite are identical in composition, and differ only in crystalline form, although one holds its charge for eleven days, and the other but for one hour.

2d. Cleavage developes excitement, as may be most easily shown in separating laminæ of Mica, and with this we may well class the effects produced by the separation of closely applied surfaces, as, for example, of a cone of sulphur from a glass in which it has been cast, or a cake of chocolate from its mould.

3d. *Change of temperature*, as when a crystal of tourmaline is heated uniformly, its pointed termination becomes positive, and its other, or blunt end, negative. As it cools, the polarities are inverted. Boracite and crystals of tartaric acid furnish good examples of a like action.

4th. Chemical action develops statical electricity, as may be shown by placing on a delicate electroscope a platinum capsule, filled with water, and suspending in it a piece of zinc connected with the earth. The electroscope will then indicate feeble positive electricity. Gassiot, with his water battery of four thousand three hundred and twenty cells, showed the various phenomena of statical electricity in a marked manner.

Combustion comes, of course, under the above head, and we will simply notice that carbon burning is negative, and the carbonic acid escaping from it is positive. So, also, hydrogen, according to Pouillet, is negative, the resulting steam positive.

It was at one time supposed, as might be gathered from the remarks of Faraday, quoted in our last number, that the mere act of evaporation developed electrical excitement. This idea must, however, now be abandoned, all the experiments which seemed to support it admitting of other explanations. Thus, if water is thrown upon hot coals placed upon an electroscope, the excitement shown results from a chemical reaction of the water and coal. If a hot platinum dish and pure water be used, no effect results, unless particles of water are violently projected from the vessel, producing friction on its edge.

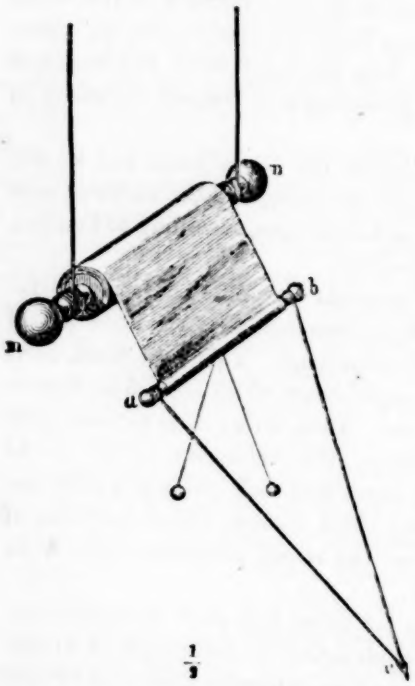
The evaporation theory being, for these and other reasons, abandoned, we are left without any explanation of the origin of atmospheric electricity, which was at one time generally attributed to such a cause. Although the origin of this grand class of phenomena must be regarded as obscure, we think that two suggestions will, in a general way at least, diminish the difficulty.

In the first place, though evaporation cannot *produce* electrical disturbance, it may greatly aid in the development and accumulation of excitement, where any slight tension and difference of state already

exists. Thus, suppose a body of small surface to be connected with one in which a feeble charge was maintained, it would receive but a small amount, and then, having a tension equal to that of its supply, would take no more. But let us now suppose that the surface is increased, more electricity will be distributed in and from this increased area. If, now, this distended body is disconnected with its supply, and then has its bulk reduced, the large quantity of electricity distributed on its developed surface will be concentrated upon the smaller area, with a proportionate increase of intensity.

This action is well illustrated by the apparatus here figured. A brass rod, *m n*, is supported by silk threads, as indicated in Fig. 12.

Fig. 12.



A long strip of gold paper is wound upon it, and terminates in another rod, *a b*, to which are attached a pith-ball electroscope, and silk threads, *a e*, *b e*. By pulling these threads, we unwind the paper, which is wound up again by the weight of *m n*, when the cord, *e*, is released. When wound up, a small amount of electricity will cause the balls to diverge; when unwound, they will collapse, unless much more is added; but when thus outspread, if only feebly charged, should the strip be allowed to wind up, the balls will diverge powerfully, showing a high tension. In other words, the fluid in excess distributes itself on the surface, and varies in intensity inversely with the amount of that surface. Should there therefore be, from such causes as we shall endeavor presently to describe, a tendency to maintain a certain state, positive or negative, on a portion of the earth's surface, vapor rising from that part would carry off a large amount, though with but feeble intensity; but on subsequent condensation and contraction, the tension would be largely increased,

being aided, no doubt, by other actions which will suggest themselves to any one, in connection with the subject of "induction," to be discussed further on.

So far for the "*development*" of excitement: next for its origin. We need not confine this to a single cause. The effect of solar heat, and its daily variation upon the dissimilar material of the earth, as well as a like action of internal fires, are, as we well know, fruitful sources of electric excitement. The vast and energetic actions by which the solar heat and light are maintained, involve, among other things, as we have reason to believe, proportionate electric developments in that central source of power, which must, in turn, by inductive action, effect our planet. In fact, such an effect may be traced in the most marked and decided manner. Thus, Herschel, in his lecture on The Sun, says, as we shall here quote, simply premising that "sun spots" are believed to be only vast storms, cyclones, or tornadoes of the sun: "There occurred, on the 1st of September, 1859, an appearance on the sun which may be considered an epoch, if not in the sun's history, at least in our knowledge of it. On that day great spots were exhibited; and two observers, far apart and unknown to each other, were viewing them with powerful telescopes, when suddenly, at the same moment of time, both saw a strikingly brilliant, luminous appearance, like a cloud of light, far brighter than the general surface of the sun, break out in the immediate neighborhood of one of the spots, and sweep *across* and *beside* it. It occupied about five minutes in its passage, and in that time traveled over a space on the sun's surface which could not be estimated at less than thirty-five thousand miles."

"A magnetic storm was in progress at the time. From the 28th of August to the 4th of September, many indications showed the earth to have been in a perfect convulsion of electro-magnetism. When one of the observers I have mentioned had registered his observation, he bethought himself of sending to Kew, where there are self-registering magnetic instruments always at work, recording by photography, at every instant of the twenty-four hours, the positions of three magnetic needles differently arranged. On examining the record of that day, it was found that at that very moment of time (as if the influence had arrived with the light) all three had made a thoroughly marked jerk from their former positions. By degrees, accounts began to pour in of great Auroras seen on the nights of those days, not only in these latitudes, but at Rome, in the West

Indies, on the tropics within 18° of the equator, (where they hardly ever appear;) nay, what is still more striking, in South America and in Australia, where, at Melbourne, on the night of the 2d of September, the greatest Aurora ever seen there made its appearance. These Auroras were accompanied with unusually great electro-magnetic disturbances in every part of the world. In many places the telegraphic wires struck work. They had too many private messages of their own to convey. At Washington and Philadelphia, in America, the telegraph signal-men received severe electric shocks. At a station in Norway the telegraphic apparatus was set fire to, and at Boston, in North America, a flame of fire followed the pen of Bain's electric telegraph, which, as my hearers perhaps know, writes down the message upon chemically prepared paper."

Such facts as these show a marked connection between disturbances of the sun, which might most naturally be supposed to involve electrical developments in that body, and electric conditions of our earth; and it is, therefore, in no wise unreasonable to suppose that atmospheric electricity may, to a great extent, be due, directly or indirectly, to the inductive influence of the sun, aided in its effects by the evaporative actions above described.

Franklin Institute.

Proceedings of the Stated Monthly Meeting, May 15th, 1867.

THE meeting was called to order with the President, Mr. J. V. Merrick, in the chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported that at their stated meeting, held May 8th, inst., donations to the library were received from the Royal Astronomical Society, the Commissioners of Patents, and the Society of Arts, London, England; the Royal Irish Academy, Dublin, Ireland; de Oesterreichischen Ingenieur und Architeckten-Veriens, Vienna, Austria; Wm. B. Thomas, Mount Holly, New Jersey; and Prof. Henry Morton, Philadelphia.

The Actuary reported that the Committee on the Library had or-

ganized by electing Charles Bullock, Esq., Chairman for the ensuing year, and appointing the first Monday evening of each month for the stated meetings.

The Committee on the Cabinet of Minerals and Geological Specimens had also organized, by electing Prof. Albert R. Leeds Chairman for the ensuing year—the future meetings to be held on the call of the Chairman.

The other various Standing Committees reported their minutes.

The Special Committee on Experiments in Steam Expansion, reported progress.

The Special Committee appointed to prepare a memorial to Congress, with reference to the establishment of an uniform Code of Danger Signals, reported progress.

The Special Committee to prepare a draft of ordinance to provide for the Inspection of Steam Engines and Boilers, reported their minutes. The paper announced for the evening was then read.

JOURNAL BEARINGS, by Coleman Sellers, Esq.

At the April meeting of this Society, there was some discussion on the subject of journal bearings for shafting. This discussion was suggested by what I had already written on the subject, and published in the *Journal* of this Institute. My statements were simply with reference to the modern American practice in that direction, and were, so far as the proportions of the bearing surface is concerned, that adopted at the establishment of Messrs. William Sellers & Co., of this city. I now propose, with your permission, to consider the subject more in detail, and to give some of the arguments which sustain the practice of such extended bearing surface as has for many years past met with favor in this country.

The transmission of power from the steam-engine, or other source of power, to the various machines which are to do the work, necessitates the use of more or less extended lines of shafting; hence the shafting, with all its adjuncts, viz: bearings, pulleys, couplings, &c., considered as a machine for transmitting power, is of necessity the largest or most extended machine in any large establishment. Upon its perfection depends the economical transmission of the power to the work, and all who use power must feel an interest in the subject of its transmission.

The wants of the present day, in this country at least, call for line shafts to run at velocities varying from fifty revolutions per minute

up to three or four hundred, and in exceptional cases to even six hundred revolutions in extended lines. Counter-shafts, or small, independent shafts, at or near the machines to be driven, vary through a still greater range, one thousand revolutions being no uncommon speed. The transmission of power to the line, and from it to the machine, is, in the majority of cases, effected by belts, involving questions of pressure somewhat different from the instances in which slow moving shafts, driven by gearing, were formerly employed. The transmission of power must or should be accomplished—1st, with a minimum loss from friction, &c.; 2d, at a moderate cost of construction. The first requirement calls for the examination of the subject in its scientific relations—in the skillful adaptation of parts of the machine to the functions it has to perform. The second relates to its commercial aspect, and has reference to the quantity, quality, durability and first cost of the material used in the construction, and, what is of the greatest importance, the amount of labor expended on its production, as well as in its final erection. I believe I may safely say, that to make machinery of this kind cheaply and well, it is essential that it should be produced in large quantities, with as little variation in its proportions as its requirements will permit. Therefore, that some general rules should be adopted that will hold in the majority of instances, leaving the exceptional cases for especial engineering consideration, and such increased cost as the case may warrant.

In considering the subject of bearings for shafting, as in the consideration of any question in applied mechanics, there must be a clear conception of the machine in its general principles and its required uses. We must fully understand what is wanted to be done before we can determine how to do it. That machine for transmitting power called a line of shafting, in its simplest form, may be defined as a number of bars of round iron, turned truly cylindrical, united by couplings, so as to form a continuous cylinder of the required length. It is supported in bearings at intervals, the bearings so arranged as to allow the cylindrical bar or shaft to rotate freely about its longitudinal axis, while they hold that axis in a right line.

In the transmission of power by a line of shafting, there is always a loss of power, due (so far as our present subject of inquiry is concerned) to the friction of the shaft in its bearings. How to reduce this friction to a minimum, with the least cost of construction, is the object of our present inquiry.

Before entering upon the subject of material and surface, I shall describe two general principles of construction of bearings for shafting.

1st. The rigid or fixed bearing, in which the bearing controls the shaft, in a degree.

2d. The swivel or equalizing bearing, in which the shaft controls the bearing.

With both kinds of bearings, the primary object to be accomplished is the maintenance of the longitudinal axis of the shafting in a right line. I shall assume, in the comparison of the two principles, that in both cases the bearings are what are called solid bearings; that is, they are formed of continuous metal surrounding the shaft. They are, in fact, cylindrical holes bored in pieces of metal, the holes being of such size as will permit the shaft to turn freely. To illustrate what I am about to describe, I have had prepared bearings embodying both principles, and of these I would first call your attention to the first, or fixed bearing. These two stands have been bored to fit this shaft. The shaft has been turned truly cylindrical, and of a sufficiently loose fit in the bearings as to allow it to turn freely in them. The base of the two stands have been planed truly parallel with the axis of the bearings, and the centre of each bearing is the same distance from the base of each. These stands are bolted to a solid piece of timber, planed true on its upper face. The timber surface being a true plane, and the base of the stands being parallel with the axes of the cylindrical holes, it is evident that by careful setting the two bearings can be brought in line with the axis of the shaft, and the shaft will turn freely in the bearings. But the springing of the timber can throw them out of line, and if the fit of the boxes is at all a close one, the least springing will cause the bearings to bind. I shall now have one of the stands loosened, and under one side of the foot I will have a piece of paper placed; this will tilt the stand slightly. The effect will be to cramp the shaft and prevent its turning. You see now it is quite rigid. The axis of the two bearings have been thrown out of line, and the increased resistance is due to the increased pressure resulting from the bearing trying to bend the shaft into conformity with its own position. This increased pressure is not a uniform one over the whole surface of each box, it is a pressure only on the parts which bind. It is, in fact, a pressure having no relation to the weight of the shaft or the work it has to do. Imagine now a long line of

shafting, supported at intervals by such bearings, and at such distances apart that the shaft cannot be used to adjust by, as in this experiment, the bearings bolted to timbers independent of each other, and not dressed to an uniform plane, as this timber has been, and some idea can be formed of the possible loss from friction in the strain of each bearing trying to twist the shaft into conformity with the position of its own axis. Careful workmanship and patient adjustment might make it measurably successful; but if attached to the floor-beams in a building, any unequal loading of the floor above will do away with all the good of such careful adjustment. Such bearings as this have been used by the thousands, and are now used in many places, but they only work at all by reason of the exceeding looseness of the fit of the bearing to the shaft, or the elasticity of the hanger and its attachment to the timber. With the bearing rigid, and only a half a box used to carry the shaft, there is less likelihood of the shaft being bound so severely as with the solid bearing; but any deviation from absolute coincidence of the axes of the shaft and box must result in the pressure being greater on one part of the bearing than on the other parts. With such an arrangement, the extension of surface, by increasing the length of the bearing, can neither produce any good result, or be in any sense a satisfactory experiment. It may, in fact, prove injurious, by increasing the liability to cramp the shaft. The advantage or disadvantage of increased area by increased length, can only be decided by the use of, and experiments with, bearings so arranged that whatever may be the condition of the rotating part of the machinery or the attachments of the hangers, absolute uniformity shall be insured over the whole surface of the bearings. That is, if there be ten square inches of surface measurable in the bearing, upon which ten inches the pressure should, in theory, be sustained, let each and every one of the ten inches bear the same pressure, and not, as with the rigid bearing, measure ten inches, but receive the pressure in a line at one or the other end of the box.

The second class of bearings, the swivel or equalizing bearing, furnishes just what is wanted for the purpose. I have here two such bearings. They are bolted upon a piece of timber, which, in this case, has not been dressed to a plane surface, but has been purposely selected on account of its crooked surface. The feet of the stands, or hangers, have not been planed. The shaft fits the bearings as accurately as in the former case, but there is an essential difference in the

arrangement of the bearings. In these the outside of the box is provided with two spherical surfaces, one on each side; the surfaces are portions of a sphere whose centre coincides with the axis of the cylindrical bearing, and is equidistant from each end. The bearing is held in place in the stand, or hanger, by this sphere fitting into correspondingly spherical cavities, which allow it to vibrate freely to a limited extent about the centre of the sphere. The shaft thrust into one of these bearings can be vibrated without disturbing the hanger. Now, passing the shaft through the two bearings, it rotates freely; in fact, with two bearings only on one shaft, any irregularity of the surface to which the stands are bolted, or any difference in length of the two stands within the limits of the possible vibrations of the box, can in no way cramp the shaft, and the pressure will be at all times equal on all parts of the bearing surface.

This solution of the problem of how to produce uniformity of pressure on the bearing, the important principle essential to the utilization of the surface, is no new invention; it had its representative existence, in some form or another, and for certain purposes, long before any of us were born. But the application of this principle, as a well understood and theoretically correct principle, to hanger bearings, and with it the extended surface of bearing which it warrants, has been more fully recognized as essential in this country than elsewhere.

The peculiar form of hanger which I have used as an illustration of the principle, was the invention of the late Mr. Edward Bancroft, and under his patent became a well recognized article of trade.

The knowledge of a good principle in mechanics does not insure its adoption. The first question as to its adoption is the commercial one, *will it pay?* will the consumer be willing to pay a higher price for an article theoretically correct, than for one which has worked heretofore, has satisfied others, and why not him? But if the correct principle can be introduced in a form that can be sold for the same price, or even less than the more inferior article, it meets with favor, and when its merits have been fully established by usage, then it takes its place as an essential feature of all similar machines.

This equalizing principle is now so recognized in this country, and would be used and would be required even at an increased cost. But, nevertheless, true economy calls for the determination of certain fixed rules and proportions, whereby, with the fewest variations in form to select from, the requirements of the greatest number of cases

may be satisfied. This leads me to the subject of area of journal bearings. I stated in my former paper on this subject, that the practice in the case of bearings for shafting, when wrought iron shafts are supported by cast iron adjustable or equalizing bearing surfaces, is to make the box of a length equal to four diameters of the shaft for the ordinary sizes of shafting, say up to four and one-half inches diameter. And I further stated, that the pressure should not exceed one hundred pounds per square inch of surface. This was given as an opinion based upon the extended practice of those who had made the matter a careful study for years.

The short discussion of the subject at the April meeting induced me to give the matter a more extended consideration. The position then taken by a distinguished engineer, I am satisfied, cannot be successfully maintained. This was, that the extent of surface given by the extreme rule proposed by me, *i. e.* length of bearing = four times diameter of shaft, is, in practice, in some cases at least, a detriment rather than otherwise; that the pressure, if the velocity be not too great, may very much exceed the specified amount, with no injury to the successful working of the machine, or increased friction. He instanced the working of screws under enormous pressure with a maintenance of lubricated surface, and no abrasion of the metal; and asserted that so far as the extent of surface was concerned, the English rule of once or once and a half the diameter of the shaft for length of bearing, is ample. This, coming from a source so eminently worthy of attention, prompted me to consider the subject in its various relations, and I will now, as briefly as possible, express my views thereon.

A line of shafting, as a machine, is designed to perform a certain amount of work, and it must be so proportioned, as to the strength of its various parts, as to enable it to accomplish its work in a satisfactory manner. Each separate part of the complex machine has a certain amount of work to do; but it does not necessarily follow that the work done by each and every part bears the same or any constant relation to the ultimate work done by the machine. Thus, with a line of shafting, the power applied by a belt and pulley at one end may be utilized by a belt and pulley at the other end of the line, less the loss of power required to perform the work due to each portion of the shaft and its attachments. As, for instance, the power required to turn the shaft against its inertia, the resistance of the atmosphere and the friction of the journals, the latter being the most important one, and the only one with which we are now interested. As friction

is in proportion to the weight, regardless of the surface, so, all other things being equal, those bearings have the most work to do which bear the heaviest load, as, for instance, those nearest to the driving belt. In fact, giving power to, or taking power from, the shaft necessitates some increase of pressure at that point over what is due to gravity alone, or produces a pressure in some direction other than that given by gravity, and necessitates some increase of power to overcome the increased friction. Power given to a shaft, by a belt and pulley of any given size and given velocity, with a tension on the belt sufficient to enable it to do the work, will give a calculable amount of work to each bearing upon which this strain comes. But by the use of too long a belt or too tight a belt, a strain may be put upon the bearings much greater than is warranted by the amount of power to be transmitted; consequently a proportional increase of frictional resistance.

In a dry condition, or when no lubricant is interposed between the rubbing surfaces, the material forming the surface influences the amount of resistance; but oil is known to diminish friction, and the investigation of Morin and others shows "that with unguents, hogs' lard and olive oil interposed in a continuous stratum between them, surfaces of wood on metal, wood on wood and metal on metal (when in motion) have all of them very nearly the same co-efficient of friction, the value of that co-efficient being in all cases included between ·07 and ·08." The lubricant cannot act as a perfect separator unless surfaces subjected to the pressure are of sufficient extent to limit the pressure per square inch to the amount which the particular lubricant will stand, without being either expelled, or crushed, as it were, by the pressure. All journals and bearing surfaces are rough. A microscopical examination of them shows them full of hills and hollows, and it is the interlocking of these minute projections which is the source of friction. The lubricant fills up the depressions and smooths up the surface. But with too much pressure, even when the lubricant is not wholly expelled, the sharp or the minute high points making up the roughness are forced through the oily films, and thus come in contact; just as on an oil-stone, flooded with oil, the sharp points of the stone passing through the oil, scratch down the hard steel surface pressed against it, the oil washing away the chips and preventing them from clogging up the stone. The same operation which takes place with the oil-stone and hard steel is constantly occurring with every bearing; the roughness of the hardest surface files down the

surface of the softest metal, except when the softest metal is made to hold a gritty substance of a nature harder than the metal rubbing on it. A steel journal, with any ordinary polish, is nevertheless rough in a degree, and capable of wearing away the surface of any softer metal which is clean or free from grit. The greater the pressure and the more freely the chips formed by the wearing process are carried off, the faster is the reduction. With any given weight on a bearing, there is no way of diminishing the pressure per square inch but by extending the surface, and with any given diameter the extension must be by lengthening the bearing. "The experiments of Mr. Nicholas Wood, confirmed by Mr. Rennie, went to show that where the area of the surface is greater than is needed for the purpose of allowing the lubricant to act as a perfect separator, that the surplus area will act as a retardant, and increase the friction by the amount of the viscidity of the particular unguent used, and he held, in the case of a wrought iron axle revolving in a cast iron bearing, that the minimum allowable pressure is about ninety pounds to the square inch." My original statement was, that in practice, the pressure should not exceed one hundred pounds per square inch, and that under this pressure the greatest economy of oil and durability of surface could be maintained. It is not always possible to insure a pressure not exceeding the one hundred pounds, and journals do work, and are every day working, under a much greater pressure, but from the lightest pressure admissible without erring on the side that will cause the stickiness of the lubricant to act as a sensible retardant, as we increase the pressure, or diminish surface under a given pressure, which is the same thing, we do it at the expense of the materials used—of the oil and the metal surfaces. It has been instanced that screws will work in a well oiled nut with a pressure of eleven thousand pounds per square inch of surface, the motion being very slow indeed; but in experiment conducted with great care, to determine the question of proportions of nuts and bolts, I found that with a pressure of seven thousand pounds per square inch, a power was exerted which should have done work equal to ten times seven thousand pounds, or seventy thousand pounds. Surely, no one could advise this excessive pressure as economical. That it should work at all, is only because its motion is so very slow. (I am now alluding to the case of a bolt or nut screwed up by hand-power.) I can state positively, from observation, that with seven thousand pounds per square inch of surface, the oil was not driven out from between the

surfaces, I suppose because the length of the spiral passage formed by the thread would not, according to the known laws of the friction of fluids, permit it; but the metal surfaces came in contact in places, and with a quick motion given to the nut, instant adhesion and cutting of the material occurred. The instance of a nut and screw not wearing under enormous pressure is in no way analogous to the continuous rotation of a journal in its bearing. The nut does not show wear in a few times running it on and off under pressure, simply because it has not had to do work with time as an element in the calculation.

In the case of shafting, the hardest work the bearings have to do is occasioned by the strain of the belts. The shafts themselves must be of sufficient diameter, and the bearing surfaces close enough together to enable them (the shafts) to resist the work required of them without springing, to any deleterious extent. Those who are familiar with the work done by shafts, and understand the capabilities of all sizes of shafts, can decide what diameter is needed in each case. Tables have been compiled from which (the power and velocity being given) the size of shaft needed can be found. Presuming that each shaft has, or is likely to have, all the work to do it is capable of doing, its bearings certainly should be proportioned to resist all the strain that that shaft is capable of working under satisfactorily. In a long line there may be some bearings which will not have other work to perform than the friction due to the weight of the shaft. These bearings might be made shorter than those which have to bear a greater weight. The extra or useless surface in these bearings can only, however, act detrimentally to the extent of the adhesive resistance of the lubricant, which, in the use of ordinary good oils, we may consider a constant but very trifling resistance, provided the bearings are so made as to insure equality of pressure over their whole surface.

In bearings so arranged, and with a pressure not exceeding one hundred pounds per square inch, I can assert, from long experience, that the wear of the surface is so little in the case of wrought iron shafts in cast iron bearings, as to be imperceptible after many years constant work. But that in proportion as the weight is increased up to the limit to be borne without actually destroying the surface, the wear is greater and greater as the pressure is increased.

When the ball and socket hanger was first introduced, the proportion determined upon for length of bearing was five times the diameter of the shaft. Thus, a three-inch shaft had a bearing provided

fifteen inches long. Bearings so proportioned worked with less frictional resistance than the old rigid bearing hanger with short bearing surface, say one or one and a half times diameter of shaft. As, however, cheapness of construction requires the least amount of material to be used consistent with the requirements of the case, so an extended series of experiments and the closest observation of the practical workings of numerous bearings, led the makers of that kind of hanger to adopt the rule as given by me, viz: four times diameter of shaft =length of bearing.

It is well, however, to consider some case analogous to shafting bearings in which experience has lead skillful engineers to adopt proportions somewhat like those applied in this case. Knowing that Mr. James Millholland, formerly Superintendent of the motive power on the Philadelphia and Reading Railroad, now President of the Consolidation Coal and Manufacturing Company, Mount Savage, Maryland, had increased the bearing surfaces of the car axles of the Philadelphia and Reading Railroad, and that the Central Pennsylvania Railroad had followed his example, I wrote to him for particulars, and received the following letter:

"MOUNT SAVAGE, Md., 27*th April*, 1867.

"*Mr. Coleman Sellers.*

"MY DEAR SIR: I have your favor of the 19th inst. Absence from home prevented me from answering until the present time. As to the advantages of long journal bearings over short ones, for any purpose, there is no doubt. Not my opinion, but my experience, has clearly demonstrated that fact.

"The Philadelphia and Reading Railroad Company furnishes an express company an eight-wheel car, to run between Philadelphia and Elmira, N. Y. When the car was first put on the route, the journals were five and a half inches long and three inches diameter, with a soft-metal bearing, with a strip of brass about an inch wide in it, which rested on the top of the journal. I found that the journals of the axles wore out before the wheels,—in fact, they did not last much over one year and were a constant annoyance, from heating. To remedy this defect, I put axles under the car, with eight-inch journals in length and three and a quarter inches diameter, and I never knew an instance of their heating. After the car had been run about one year with the long journals, I had one of the bearings removed, (it was made in precisely the same manner as the short one,) to examine it and the journal, and could see no perceptible wear in either of them.

"A bearing made as I have described, I believe, is much better than a brass one. Plugging a brass box is not a good plan to intro-

duce soft metal; it leaves a brass edge; this will crumble off, and make it liable to cut, no matter if the edges of the bearing is rounded off. When soft metal is put into a bearing it should be the entire length of it.

"If the axles of a car would admit of it, I would make the journals quite as long as you make the bearings of your shafting. But you will perceive it would throw the weight on the axle too far from the wheel, thereby necessitating a much longer axle, in consequence of the great overhang of the wheel, which is not the case with your shafting, but in favor of it, as you are enabled to make lighter shafting, which you know is a desideratum, particularly at high speed, as there is less matter to keep in motion, consequently less power is required to drive it. I did not go into the matter of long journals for railroad cars without investigating the matter as to their safety. I knew the Pennsylvania Railroad Company's car-wheels had a long hub on the outside of the wheel, and must necessarily require a much longer axle than usual, the gauge of their road being the same as the Philadelphia and Reading Railroad. And I made the centre of the long journal axles about the same length as the short journal axles of the Pennsylvania Railroad. That road is now, I believe, increasing the length of the journals of their axles to seven inches. This fact, however, you can easily ascertain, as you now live in the neighborhood of their shops, in West Philadelphia.

"I consider that the want of a long journal on the axles of railroad cars has been a source of great annoyance and expense in the operation of railroads, and that they will be universally adopted.

"Very truly, yours, &c.,

"JAMES MILLHOLLAND."

The bearings for car journals are so made as to tend towards equalizing the pressure over the entire surface. That is, the bearings are loosely fitted into the boxes, and allowed space to rock in, so as, in a rough way, to fulfill the requirements of an equalizing bearing. Assuming the maximum load ever carried by a car, and the weight of all parts of the car which rests on the journals, as a constant pressure on the journals, we find that the three-inch journals, five and a half inches long, had to sustain a pressure of three hundred and eighty pounds to the square inch, while the three and a quarter inch journals, eight inches long, would have a pressure, under the same circumstances, of about two hundred and twenty-five pounds per square inch. This is on the supposition that the two years' work compared by Mr. Millholland was constantly under the maximum load, which, however, is not at all likely, and the pressure which destroyed the bearings and axles with the small surface, was in all probability seldom more than two hundred and fifty pounds per square inch. I

have already consumed too much time to dwell at length on the material composing bearing surface. But I will state, that if surface sufficient to insure the intervention of an oil film be obtainable, first cost as well as other considerations point conclusively to cast iron as the proper material. The hardness, uniformity of texture, specific heat, &c., of cast iron are in its favor. The best so-called brass bearings are those formed of pure copper and tin, in the proportion of six to one. The chief argument in favor of its use is its superior heat-conducting properties. It lacks, however, the uniformity of texture found in even ordinary cast iron, and so far as specific heat is concerned, I have it on the authority of Miller, in his recent Physics of Chemistry, that "mixtures of copper and tin, of eight to one even, has a specific heat of but little better than tin, hence but little better than cast iron. Accepting the truth of Joule's assertions, that all force is measurable by heat, that the friction in every journal results in the production of a fixed amount of heat, in proportion to the work done by the journal, not the work transmitted through the shaft, but the work done by the bearing in supporting the weight imposed on it, with the surfaces sliding under the pressure at a given velocity: it follows that the frictional resistance is the same in the case of two bearings, one brass and the other iron, and that that frictional resistance is due rather to the vescidity of the lubricant than to the surface; that if surface of exposure to the air or conducting material in close contact, be properly supplied, so as to take off the heat as generated, the slight advantage due to the conducting power of brass is as nothing compared to the additional cost of the material.

But in practice, examining some interesting cases, cast iron gear-wheels outwear exactly similar brass ones under the same work, two to one. In the spindle of throttle-frames, which are hardened and polished, running at high speed—nine thousand revolutions per minute—brass bearings wear out rapidly; cast iron ones, of similar shape, show no appreciable wear after much longer service. Cast iron boxes for lathe spindles, in use for over seventeen years, are reported to me as good as new, with no repair and constant and not over careful usage. In fact, without multiplying examples, I may say that brass seems to have nothing to recommend it for shafting purposes except the doubtful merit of increased cost—like Hood, with his soap experiments. He found that when different soaps were submitted to his laundry maid to test, the best report was always given in favor of the one to which he had affixed the highest price, no matter what may

have been the real first cost. Brass, however, finds its place in marine work, from its non-oxidizing qualities, and in cases in which the pressure must exceed the limits of safety for cast iron bearings, it may work drier, and not stick to the shaft and tear up the surface so soon as cast iron will under similar circumstances. If cast iron begins to cut it, the destruction progresses more rapidly than with brass. I have collected much valuable information, which confirms me in my former statement as to the disadvantage of the so-called soft metal for shafting bearing surface, but I have already occupied too much of your time to allude to them.

The rule for short bearings is still held in the practice of the engineers in England and in Europe, but they, as a general rule, run their shafts in brass rigid bearings. The equalizing principle of bearing has long been known there, and in some cases it has been adopted, but it is not considered an essential principle, as it is in this country. Their maxim has been to furnish rigid bearings attached to rigid supports, not likely to get out of line. Practical machinists who have worked in the leading shops abroad, give me this information. In the most modern work which I can find on the subject of Mill Gearing, (I allude to one recently published by A. Fullarton & Co., of Edinburgh and London,) tables were given for size of shaft and proportion of journals, with the remark—

"These tables, it may be remarked, are derived from actual practice, and are those that are used in one of the largest and most celebrated millwright establishments in the kingdom." They discuss rigid bearings, lined with brass, and comment on the improved way of making the box, whereby the brasses are fitted into place in the lathe, and giving as the proportion of length—

Two-inch journals,	5	inches	length.		Five-inch journals,	9½	inches	length.
Three-inch "	6½	"	"		Six-inch "	11	"	"
Four-inch "	8	"	"		Seven-inch "	12½	"	"

This shows that although we would consider their bearings as short, yet they have, evidently, of late, made them longer than the old rule, of one or one and a half diameter of length, as in the case of two-inch shaft they make the bearing two and a half diameters, four inch, two diameters, &c. In fact, they seem to have taken, in all probability, the extreme length admissible with a rigid bearing, and then use brass for the bearing surfaces.

In conclusion, I would state, that my own conviction, after careful

consideration, and the knowledge derived from those who have made the shafting branch of the machine business a life study, that the minimum first cost is obtainable from the use of cast iron bearings, made according to some fixed rule or proportion, which shall, by answering for the majority of cases, enable the manufacture to be conducted in a systematic and economical manner; that the minimum frictional resistance is obtainable from cast iron bearings, made so as to equalize the pressure over the whole bearing surface; that the length of bearing for the ordinary sizes of line shafting should be equal to four diameters of the shaft; that sufficient material must be provided to sustain the load and to distribute the heat generated by friction. And, from the examination and analysis of numerous cases in practical operation, the maximum work which a shaft is capable of doing advantageously, that is, work satisfactory, and with no need for repairs, year after year, if supported at intervals of eight feet by bearings of the proportions above named, will give to the bearings in question about the pressure of one hundred pounds per square inch, the available surface being computed at one-fourth the circumference of the shaft. The wear will be diminished in proportion as the surface is extended. The recognition of the equalizing principle, and its adoption in practice, gives an assurance of uniformity of pressure over the whole surface used.

The extension of surface under an equalized pressure can only act detrimentally to the extent of the cohesion of the oil, while the light pressure is in favor of the retention of oil and its preservation in good working condition.

Hence, the only argument in favor of diminishing the surface to the minimum allowable proportion of the old millwrights, viz: one or one and a half diameter of shaft for length of bearing, would be the saving of material in the first cost of construction, an economy akin to parsimony, and resulting in a constant repair account and source of anxiety to all using the machinery.

The verbatim notes of the phonetic reporter not having been returned by all those engaged in the discussion, this part of the Proceedings will be deferred to the next number of this *Journal.*

The second paper announced for the evening, by Richard Gilpin, Esq., on the Construction of Docks and Wharves, was then read.

The Report of the Resident Secretary was then read, and the meeting was, on motion, adjourned.

HENRY MORTON, *Secretary.*

A COMPARISON *of some of the Meteorological Phenomena of* MAY, 1867, *with those of* MAY, 1866, *and of the same month for* SIXTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By PROFESSOR J. A. KIRKPATRICK, of the Central High School.

	May, 1867.	May, 1866.	May, for 16 years.
Thermometer—Highest—degree	87·00°	84·06°	90·00°
" date	29th.	13th.	7, '60; 23, '63.
Warmest day—mean	78·67	70·17	79·83
" " date	29th.	27th.	23d, '63.
Lowest—degree	36·00	44·00	35·00
" date	4th.	3d.	7th, '54.
Coldest day—mean	43·17	50·33	40·00
" " date	3d.	3d.	3d, '61.
Mean daily oscillation	17·64	16·06	16·98
" " range	5·30	5·65	5·57
Means at 7 A. M.	54·10	56·71	58·25
" 2 P. M.	64·92	67·73	69·41
" 9 P. M.	56·50	60·10	61·16
" for the month	58·53	61·51	62·94
Barometer—Highest—inches	30·423	29·940	30·423
" date	4th.	8th.	4th, '67.
Greatest mean daily pressure	30·367	29·901	30·367
" " " date	4th.	7th.	4th, '67.
Lowest—inches	28·778	29·156	28·778
" date	8th.	28th.	8th, '67.
Least mean daily pressure	29·013	29·277	29·013
" " " date	8th.	27th.	8th, '67.
Mean daily range	0·214	0·131	0·127
Means at 7 A. M	29·855	29·633	29·799
" 2 P. M	29·804	29·598	29·761
" 9 P. M	29·836	29·628	29·788
" for the month	29·832	29·620	29·783
Force of Vapor—Greatest—inches	0·625	0·694	0·771
" date	29th.	27th.	14th, '54.
Least—inches	·139	·128	·069
" date	4th.	3d.	2d, '61.
Means at 7 A. M	·310	·310	·353
" 2 P. M	·305	·324	·368
" 9 P. M	·320	·334	·375
" for the month	·312	·323	·365
Relative Humidity—Greatest—per cent	96·0	93·0	100·0
" date	8th.	17th.	Often.
Least—per cent	29·0	25·0	16·0
" date	2d.	24th.	5th, '55.
Means at 7 A. M	71·3	64·1	71·0
" 2 P. M	48·1	46·7	51·0
" 9 P. M	67·5	62·7	68·3
" for the month	62·3	57·8	63·4
Clouds—Number of clear days*	7·	11·	9·9
" cloudy days	24·	20·	21·1
Means of sky covered at 7 A. M	62·8 per ct	45·1 per ct	58·8 per ct
" " " 2 P. M	67·9	64·2	61·6
" " " 9 P. M	50·0	55·2	47·8
" " for the month	60·2	54·8	56·1
Rain—Amount—inches	7·070	4·633	4·957
No. of days on which rain fell	12·	9·	12·5
Prevailing Winds—Times in 1000	s 82°24′w·099	s 77°14′w·333	s 83°16′w·121

* Sky one-third or less covered at the hours of observation.

A COMPARISON *of some of the Meteorological Phenomena of the* SPRING *of* 1867 *with those of* 1866, *and of the same Season for* SIXTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By PROF. J. A. KIRKPATRICK, of the Central High School.

	Spring, 1867.	Spring, 1866.	Spring, for 16 years.
Thermometer—Highest—degree.	87·00°	84·00	90·00°
" date	May 29.	May 13.	May 7, '60, 23, '63.
Warmest day—mean	78·67	73·17	79·83
" " date	May 29.	Ap. 21.	May 23, '63.
Lowest—degree.	20·00	18·00	4·00
" date	Mar. 15.	Mar. 26.	Mar. 10, '56.
Coldest day—mean	25·67	28·50	11·50
" " date	Mar. 18.	Mar. 26.	Mar. 10, '56.
Mean daily oscillation	16·01	14·69	15·96
" " range	5·62	6·37	5·98
Means at 7 A. M	45·15	48·06	46·77
" 2 P. M	55·38	58·15	57·93
" 9 P. M	48·71	51·92	50·53
" for the Spring	49·75	52·71	51·74
Barometer—Highest—inches	30·485	30·252	30·522
" date	Mar. 15.	Ap. 17.	Mar. 3, '52.
Greatest mean daily pressure	30·450	30·203	30·458
" " " date	Mar. 15.	Ap. 17.	Ap. 3, '54.
Lowest—inches	28·778	28·820	28·778
" date	May 8.	Ap. 23.	May 8, '67.
Least mean daily pressure.	29·013	29·051	28·884
" " " date	May 8.	Ap. 23.	Ap. 21, '52.
Mean daily range	0·228	0·146	0·164
Means at 7 A. M	29·951	29·786	29·828
" 2 P. M	29·904	29·730	29·782
" 9 P. M	29·927	29·763	29·813
" for the Spring	29·927	29·760	29·808
Force of Vapor—Greatest—inches	0·625	0·694	0·771
" date.	May 29.	May 27.	May 14, '54.
Least—inches	·060	·066	·023
" date	March 29.	Mar. 17.	Mar. 5, '58.
Means at 7 A. M	·246	·250	·250
" 2 P. M	·229	·272	·265
" 9 P. M	·241	·277	·270
" for the Spring	·232	·266	·262
Relative Humidity—Greatest—per cent	96·0	95·0	100·0
" date	May 8.	Mar. 21.	Often.
Least—per cent	21·0	18·0	13·0
" date	April 6.	Ap. 29.	Ap. 13, '52.
Means at 7 A. M	70·1	68·4	71·7
" 2 P. M	50·3	52·1	51·9
" 9 P. M	66·2	66·4	67·7
" for the Spring	62·2	62·3	63·8
Clouds—Number of clear days*.	23·	26·	27·8
" cloudy days.	69·	66·	64·2
Means of sky covered at 7 A. M	65·3 per ct	57·5 per ct	60·9 per ct
" " " 2 P. M	66·6	69·7	63·7
" " " 9 P. M	51·4	54·5	49·4
" " " for the year	61·1	60·5	58·0
Rain and melted snow—Amount—inches	14·100	9·590	12·856
No. of days on which rain or snow fell.	40·	30·	36·4
Prevailing Winds—Times in 1000.	N29°59′W·123	N80°37′W·251	N70°18′W·180

*Sky one-third or less covered at the hours of observation.

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EDITORIAL.

ENGINEERING ITEMS.

Pneumatic Despatch.—This subject was discussed by us some time since in connection with the arrangement which has been for many years used in London to convey packages of goods and mails from one part of the city to another. We now find in *Engineering*, page 609, a description of an apparatus much less extensive, but equally effective within its own domain, by which written despatches are carried from place to place in leaden tubes, protected externally by split pipes of wrought iron. The messages are enclosed in little carriers of gutta-percha, and are sucked or blown through the tubes, by air pressure or vacuum developed in large reservoirs by a small steam-engine and air-pump.

This system was devised by Mr. Latimer Clark, and has been in use, for some fifteen years, between the Electric Company's Central Station, Lothbury, the Stock Exchange and other branch offices.

A plan, similar in its general features, is exhibited by Messrs.

Mignon & Rouart, of Paris. Here, however, wrought iron pipes, internally glazed, are employed, and a vacuum, or compressed air, is secured by the use of reservoirs filled with the hydrant water.

It is calculated that forty messages can be sent in each carrier; twelve carriers together, or in one train, and twelve trains per hour. Messrs. Siemens & Halske exhibit drawings of a similar contrivance employed by them in Berlin.

Wood-working machinery, by American constructors, in the Paris Exhibition, is highly commended in *Engineering*, page 665. Special reference is made to that exhibited by Mr. B. D. Whitney, of Winchendon, Mass., which, beside various merits of detail, is characterized by a remarkable combination of lightness and strength worthy of study and imitation. Among the machines shown by Messrs. C. B. Rogers & Co., of Norwich, Conn., is one for making pencils, which performs all the operations needed, from cutting out the rough boards to finishing the articles, by simply making a change in the cutters. A large lot of material is, of course, treated successively for the different steps.

The cask-making machines of Messrs. Cool, Ferguson & Co., Glens Falls, Mass., and the fret-cutting saw or scroll-saw of Messrs. Wright & Smith are highly praised for their ingenuity and excellence.

Tunnel under the Chicago River.—We learn from the daily papers that this work has met with a mishap, a portion having fallen in and thus occasioned heavy loss and considerable delay. The work has, in fact, been abandoned by the contractors. The progress made was not very great at the time of the accident, consisting, as we learn, simply of the preliminary vertical shaft, which caved in for want of sufficient shoring, engulphing, among other things, a coal yard with its store of fuel, which may thus have to undergo a double process of mining.

An offer has been made, as we are informed, for the construction of a cast iron tunnel, on the same ground, by General Palmer and others. The tunnel is to be lowered in sections upon a bed previously prepared, the sections being bolted together, under water, by divers, and the tunnel, when finished, to be pumped out.

The Pacific Railroad is now (June 23) open to Julesburg, 376 miles west of Omaha, at which point over 5,000,000 lbs. of freight are awaiting transit.

Nitro-glycerine has been employed for blasting on the above road with good success, and no accidents. Some two thousand blasts have been fired with this substance during the last two months.

Rotating Ingot Moulds for Bessemer Steel.—In *Engineering*, page 637, we learn that moulds rotating on their axes, at a moderate velocity, so as not to throw out the metal, have been employed with success by Messrs. Jackson & Co., at Imphy, France, to avoid the formation of those air-bubbles in the casting, which are noticed by our able correspondent, Prof. D. V. Wood, in his letter of this month.

The fluid metal, receiving an impulse toward the periphery of the mould, allows the gas to escape the more readily by the centre, where it remains longest in a melted state. M. Treska, from an examination of polished sections cut from castings thus made, thinks that they show a great, or even entire, freedom from the black specks found in all other specimens, and doubtless resulting from the bubbles formed in the original ingots.

Whitworth's apparatus for compressing steel, with the same object as the above, is explained and illustrated in *Engineering*, pages 615 and 616. In this, pressure is brought to bear upon the metal while solidifying, provision being made, at the same time, for the free escape of gas.

The Air Engine by P. Shaw, of Boston, is mentioned among the interesting objects at the Paris Exhibition. In this apparatus, the fuel is burned in a close chamber supplied with air under pressure by the engine, and the total products of combustion are used as motive power in the cylinder.

The Suez Canal.—An interesting paper on the steam dredges used in this work, was read before the Institute of Mechanical Engineers, at their meeting, held at Paris, June 6th. From this and other contemporary sources we gather some important particulars with reference to this most interesting work.

It appears that two trenches have been dug, by hand labor, from Port Said, on the Mediterranean, through the shallow lakes of Meuzaleh and Ballah, across the table land of El Ferdane and Serapeum, cutting the high ground at Chalons, and, after rounding a bed of rocks, across the plains to the Red Sea at Suez. These trenches having been filled with water from the lakes, are employed, one on the Asiatic side, for the dredges by which the enlargment is conducted, the other, or African trench, for the use of boats bringing supplies from Port Said. Previous to this work, however, it should be mentioned, that the fresh water canal of Ouady, from the Nile, was continued to Ismailia, about the middle point of the works, and commu-

nication was then established between the Mediterranean and the Red Sea, by continuing this fresh water canal from Ismailia to Suez. The greater part of the land through which the canal runs is composed of sand and mud, or clay and gypsum, capable of being worked with a dredger. In fact, it appears that, at no distant time, the distance between the two seas was less than sixty miles, including the lake Timsah, formerly fed by the Nile, with a bottom nineteen feet below the level of the sea, but now dry.

The Mediterranean has, however, receded about thirty-seven miles, leaving behind it shallow lakes or marshes, and the Red Sea has retired about nine miles, leaving a plain little elevated above the level of high-tide.

For this reason, it will be seen that the dredging process may be applied, with excellent effect, throughout a great distance. The dredges employed are of extraordinary size and power, and especially adapted to the requirements of delivering the excavated material at a great distance from their point of work. For a full description of the many ingenious contrivances employed, we must refer our readers to *Engineering*, page 603.

NOVELTIES IN CHEMISTRY AND PHYSICS.

Isappearance of the Lunar Crater Linné.—The first report of the above remarkable occurrence seemed so doubtful that we refrained from notice of it, preferring to give our space to more important and well established facts. Full confirmation has, however, been now obtained, and we therefore proceed to furnish our readers with a detailed account.

In the *Monthly Notices of the Royal Astronomical Society* for this year, No. 3, page 93, we have a paper on this subject by Wm. R. Birt, Esq., the substance of which we will now give.

The attention of the writer was called to this subject by a letter of Herr Schmidt, Director of the Observatory at Athens, an extract from which is given, which we here translate:

"ATHENS, *November* 17, 1866.

"SIR: For a long time past I have found that a lunar crater, located in the plane of the Mare Serenitas, has ceased to be visible. This crater, named by Mädler "Linné," is found in the fourth section of Lohrman under the sign A. I have known this crater since 1841, and, even at the full moon, it is not hard to distinguish. In October

and November of 1866, at the time of its maximum distinctness, that is to say, once a day, after the rising of the sun on its horizon, this deep crater, of which the diameter is 5·6 English miles, had entirely disappeared; only a glimmer or little whitish cloud presents itself in the place of Linné. Will you be so kind as to make some observations in this locality.

"J. F. JULIUS SCHMIDT."

The earliest information respecting the crater I received from Mr. Buckingham, who favored me with a copy of the photograph taken by him on November 18th, 1866. On this photograph the place of "Linné" is visible, but faint. I have during the last lunation received records of observations from the following gentlemen: Doctors Mann and Tietjen, and Messrs. Talmage, Webb, Slack, Grover and Jones. On the 13th, when the terminator passed over the east boundary of the *Mare Serenitatis*, the place of "Linné" was seen by Messrs. Webb and Talmage; Mr. Webb's aperture 9¼-inch silvered glass reflector and Mr. Talmage's 10-inch refractor of Mr. Barclay, at Leyton. Mr. Webb described the appearance as an ill-defined whitishness on the site of "Linné." Mr. Talmage recorded "a dark circular cloud." The exact position of these appearances was carefully ascertained afterwards and found to agree with the place of "Linné." Doctor Mann and I, at Leyton, were prevented by a thin veil of cirrus seeing the "cloud" recorded by Mr. Talmage. With smaller apertures, both Mr. Grover and I were unable to detect the slightest trace of "Linné," while the small crater, "Linné B," of Beer and Mädler, and also Bessel, were very distinct *with the shadows within them.* On the following evening, December 14th, observations were made by Messrs. Webb, Slack, Grover and Birt. A white spot was seen in the position of "Linné." Mr. Webb described it as the most conspicuous object on the E. half of the *Mare Serenitatis.* Mr. Slack saw a whitish spot not remarkably bright, but could see no trace of a crater. Mr. Grover recorded "a tolerably defined roundish whitish speck," but he could not see the interior or margin of the crater, and "in this respect the spot showed very different from Bessel and other craters which were well seen." My own observations perfectly agree with the above. I estimated the light at 3°. On the 15th the spot was brighter, and I obtained the measures recorded below. On the 16th Messrs. Jones and Grover described the appearance as a white spot not over bright.

On the 20th Professor Foërster and Dr. Tietjen observed "Linné" with the Berlin refractor. The following is the translation of the

letter which I received from Dr. Tietjen, dated Berlin, December 21st, 1866:

"On viewing the moon last night about 13^h M.T. Berlin with our refractor, in order to convince ourselves of the disappearance of the crater 'Linné,' Professor Foërster and I perceived that crater very distinctly. If, therefore, an obscuration has taken place, on which certainly no doubt can exist, as it is affirmed by so competent an authority as Herr Schmidt of Athens, it has evidently now ceased."

Although Dr. Tietjen considers that the obscuration *has ceased*, it does not appear that either he or Professor Foërster *has seen into* the crater.

The whole of the observations are so accordant among themselves, and the measures appended so clearly indicate the white spot to be larger than the crater "Linné," as to leave no doubt that a change of some kind has taken place; and this conclusion appears to be supported by previous records.

Schröter, in plate IX. of his *Selenotopographische Fragmente*, gives a large dark spot in the place of "Linné;" and the Rev. T. W. Webb informs me that "Linné" is not to be found on Russell's globe or maps, 1797, from which it may be inferred that the crater has previously been obscured.

Among other confirmatory observations of this remarkable phenomenon we have the following, which we translate from C. R., p. 345.

"On the evening of the 10th of February, P. Secchi saw, between nine and ten o'clock, the lunar crater Linnæus enter the sunlight, and there was seen, near its outside circle, a little prominent point with a little shadow, and, surrounding this point, an irregular circular crown, which was very flat. The dimness of the light, and the proximity of the moon to the horizon, did not permit a prolonged observation.

"On the 11th, Linnæus was already sufficiently advanced in the sunlight, and at seven o'clock there was plainly seen a little crater, surrounded by a brilliant white halo, which shone distinctly on the deep shadows of the Sea of Serenity. The size of the orifice of the crater was at least half a second larger, and the halo was a little larger than Sulpicius Gallus.

"I insist on this comparison, because it shows that MM. Mädler and Beer, whose beautiful map I use, could never have represented as such a clear and well-defined crater as that which they have called Linnæus, the white spot which now exists.

"Sulpicius Gallus is actually much larger than the little crater which forms the centre of the spot. This last is even yet smaller than those craters, which are only indicated by letters, which are not named, and are scattered at considerable distances over the Sea of Serenity.

"One cannot doubt that a change has taken place, and it seems probable that an eruption has filled up the old crater with material so white, that it seems much brighter than the bottom of the sea which surrounds it."

A New Ice Machine by M. Carré.—We translate from a note by the inventor, in *Comptes Rendus*, page 897, the following particulars of his new device:

"The apparatus which I have the honor of placing before the Academy is founded on Leslie's experiments, of which it is the normal development—a development which permits one to work on any scale and attain successful practical results. The experiments of the Scotch Doctor are the creation of a principle, whilst my apparatus puts them in practice.

"The first problem to be solved was to make a simple air-pump, which would cost but little, was easy to make and operate, constant in its effects, and which would however make a 'current' vacuum with about one millimètre of mercury, without being changed by emanations from acids. The apparatus before you cost, at most, sixty francs, has been worked eighteen months without repairing, and produces ice with dilute acid of 52° B.

"In the second place, it is necessary to devise a way of bringing in contact, vapor of water and acid, which, without sensibly enfeebling the tension of the flow of gas, permits it, notwithstanding, to dilute the acid so as to cause it to give the best effect. There are two principal modes leading to this result. The first consists in allowing a small stream of acid to circulate in a tube in which flows at the same time vapor of water; the second, in terminating the outlet tube of vapor by an horizontal movable tube, which enters the bath of acid, and which rises, as the acid augments in volume, by absorbing the vaporized water.

"The acid receivers are formed of an alloy of lead with from five to six per cent. of antimony, supporting, without change of shape, a pressure of from five to six atmospheres, whilst the strain to which it is submitted cannot exceed one atmosphere. It has been subjected to sufficient trial to show that it can resist twenty years of constant contact with sulphuric acid, which, after attacking the surface, at

first forms a crust of sulphate of lead, which preserves it entirely from any after corrosion.

"The copper pump is preserved from contact with the sulphurous acid (which is always given off from acid which has recently been introduced) by an arrangement which constantly bathes its interior surface with oil. This oil, instead of injuring its physical working, secures, on the contrary, all that is desirable. The valves are moved mechanically, and cannot be disarranged.

"From this concise description, we see that this apparatus, which maintains a vacuum during several months, produces from two to three kilogrammes of ice with one kilogramme of acid of 66° B., no ice being obtained until it has been diluted to 52°. The freezing commences generally about three or four minutes after you commence to create a vacuum. If you only wish cold water of from three to four degrees, two minutes only are necessary, and an agitation of a few moments will restore the air which it lost in the vacuum.

"Besides sulphuric acid, which is the most economical to employ, I use different powerful hygrometric agents, amongst which are potash and caustic soda, which are distinguished by the promptness and intensity of their action.

"Without entering into an enumeration of various applications of this system, I will mention two which appear to me the most interesting: First, on ship board; secondly, as coolers for household purposes, it being possible to preserve indefinitely a temperature of from five to six degrees in all latitudes; these results can be obtained by means of dried chloride of calcium, and are absolutely exempt from all danger, in all cases, and, the dissolved chloride being indefinitely recovered, the expense is nothing."

An Ice Machine.—We translate the following from *Les Mondes*, not because we understand the apparatus it describes, but in the hope of eliciting information. Constant reference is made in foreign journals to this machine, and the following is the nearest we have seen to an explanation:

"M. Toselli invented, some time since, a very simple apparatus for making ice, and lately has been engaged in making one on a large scale, which will manufacture ice at the rate of ten kilogrammes an hour, and one hundred kilogrammes in ten hours of work. There is nothing more effectual, and less objectionable, than this freezer by the circulation of steam. The steam is made, in the first place, by a generator, which is heated in a vessel of boiling water,

under a relatively low pressure. The steam passes all around series of movable cylinders, which turn, and are very easily displaced, by means of a handle, which can be moved by a child. The ice is formed, even on the surface of the cylinders, in moulds or matrices, which lie in uncongealed liquid baths of water and alcohol, in which the cylinders turn. In this apparatus a very curious formation of ice takes place. The bed of ice deposited on the cylinder has all the hardness and transparency of natural ice, which cannot be obtained by any known freezer. After having read in *Les Mondes* the description of this apparatus, his majesty the Emperor had it tried at the Tuilleries, and greatly admired the quantity, quality, hardness and transparency of the ice which was immediately formed by the circulation and condensation of steam formed by the little furnace. The freezer, constructed in this way, is for the use of large chemical manufactories, castles, hotels, hospitals, etc., etc."

Tungsten Steel by the Bessemer Process.—We translate, from the *Comptes Rendus*, page 609, the important parts of a note by M. Le Guen:

"The superior quality of steel made of wolfram is well known; it is only desirable now to make it in large masses. I have succeeded in doing this by the Bessemer process, at the steel works at Imphy. The steel was made as usual, taking 3200 kilogrammes of a gray iron which is known to make the best steel, by the addition of 400 kilogrammes of a white laminated iron—the spiegel-eisen—which is obtained in Prussia, being, after fusion in the reverberating furnace, decarburetted in the convertor. Then, instead of spiegel-eisen, we added 400 kilogrammes of an ore containing tungsten. We thus obtained a steel capable of being tempered and forged, and which was well laminated. When made into railroad iron, wagon-springs and sheet iron it has resisted severe tests.

"I here give the results of my experiments:

"1st. That you can use the Bessemer process to combine tungsten and steel.

"2d. That the loss of tungsten, found by analysis, is comparable to that found in other processes previously tried.

"3d. That an ordinary, even rather impure, gray coke iron has become, when treated with wolfram, susceptible of transforming into steel of good quality the decarburetted metal in the convertor, which opens a vast field for research and employment of irons which are likely to give steel of any desired quality.

"4th. Finally, by means of this method, it is possible to obtain pieces of large dimensions of Bessemer steel made with tungsten."

An Interesting Mineral Specimen. — There was presented lately to the collection of the Franklin Institute a specimen of great interest, not only in itself, but also in its relations with the history of mineralogical chemistry. This is a portion of the first cake of metallic copper produced at Riechelsdorf (1845) from the working of the copper slates (Peruvian formation), containing great numbers of minute black crystals, which were proved to be alotropic modifications of oxide of nickel by Dr. Genth (who was then completing his studies in the laboratory of Bunsen), whose name and determinations in connection with subjects of chemical analysis are so widely known, not only in this country, but also in Europe. Berzelius, to whom like specimens were shown after their discovery by Dr. Genth, was so much surprised by the character and location of the body, that it was only by tests, applied with his own hands, that he could convince himself of the fact.

The new substance for anæsthesia.—The new agent for anæsthesia, of which we have already spoken, in the *Cosmos*, some time since, and which is known as the quadrichloride of carbon, $C Cl^4$, has recently been the subject of Dr. P. Smith's investigations. It appears that this composition has the agreeable odor of quinces is capable of producing anæsthesia in a very short time, often in half a minute, and that insensibility can be sustained, with or without loss of consciousness, that these effects are easily checked, that anesthesia is produced without excitement, and is not followed by nausea. It is employed for headaches, which it cures instantly, and for other pains. The editor of the *Lancet* states that this agent is preferable to chloroform in many cases.—*Cosmos*, p. 633.

Editorial Correspondence.

THE BESSEMER STEEL WORKS AT TROY.

A FEW weeks since, I visited the Bessemer Steel Works, at Troy. When all the machinery which they now have under way is in full operation, they will be able to turn out fifty tons of steel a day. Most of the steel is cast in ingots of several hundred pounds each, but they can make small castings with it. I was pleased to learn that they could make castings moulded in sand, but in all cases they

are very full of blow-holes. They however assert that, notwithstanding the blow-holes, the castings are twice as strong as similar ones made of cast iron. There is considerable waste in making small castings of this steel, and they are therefore obliged to charge heavily for those made, but, as a general thing, they decline to make very small ones at any price. The castings should, if possible, be worked under a hammer. Castings of ordinary cast steel can be secured at Pittsburg and Jersey City. The Bessemer steel is not intended to take the place of, or compete with, ordinary cast steel, the properties of the two being quite different in several respects. At Troy they are preparing to make steel rails for railroads, and in Vermont a company is establishing works to manufacture steel locomotive tires.—D. V. W.

University of Michigan.

DRILLING MACHINES AT THE HOOSAC TUNNEL.

ANN ARBOR, MICHIGAN.

EARLY in June last, I visited Hoosac Tunnel to witness the operation of the power-drills. Machines have been introduced at the east heading only, where they work eight at a time. These are driven by compressed air, at a pressure of thirty pounds per square inch. The air is compressed by water-power, supplied by the Deerfield river. In the tunnel are two heavy frames or carriages, to each of which are mounted four machines. When I observed them, they made about 180 strokes per minute, and drilled an inch and a half hole about three-fourths of an inch per minute. They may be worked more rapidly at a higher pressure of the motor. All the movements of this machine are automatic, except the advance feed. It appeared to require the constant attendance of a man to see that it did not feed too fast. It seems that this part of the problem has troubled most inventors of drilling machines. They have either failed to make them automatic and self-adjusting, or else the devices have been so costly and delicate, that they were of little practical value. But Professor Robinson (my assistant in the University) and myself have invented a method which, we think, entirely overcomes the difficulty. It is cheap, strong, simple in its structure, and *perfectly automatic and self-adjusting*. It will feed four or five inches at a stroke, if necessary; but, if the cutting does not advance, it will not feed any. If the other parts of a drilling machine can be made as strong and simple as this, no further difficulty will be experienced with them.

Several machines have been tried in the tunnel, but all have failed, except the one now being used. Massachusetts expended about $13,000 in experimenting upon these machines, which resulted in the construction of the Brooks, Burleigh & Gates' machine, which promised well at first, but which was cast aside after five or six months' trial. They broke so rapidly that they could not keep a supply in the tunnel, and at one time there was only one at work. The machine which they are now using (Burleigh's) is a great improvement over all others tried, so far as breakage is concerned. A few men in the repair shop can keep them in running order, and they can do more work with them.

The failure of so many machines was casting a doubt over the minds of many about the success of drilling machines, and the question of abandoning them at present, and resorting to hand-labor only, was seriously discussed. This doubt was strongly entertained by the consulting engineer, Mr. Latrobe, (see Report of the Commissioners, House Doc., No. 30, p. 57.) He *advised* their removal and a resort to hand-labor, but recommended that experiments be made outside the tunnel. But, fortunately for science, as well as for the advancement of this particular work, the use of the machines has been continued, and they are now making nearly double the advance ever made by hand-labor. The average advance, for several months in 1865–66, by hand-labor, was 55¼ feet per month. When I was there, they were advancing at the rate of nearly 100 feet per month with machines. I doubt not they will yet make more rapid progress. In Mont Cenis—the great Italian tunnel—they have advanced at the rate of 7 feet per day, or 162 feet per month of 26 days. In that tunnel they do not observe the Sabbath, and hence they make over 200 feet monthly. But such a rate cannot be expected in Hoosac, on account of the peculiar character of the dip of the rock. The rock is friable, and the blast does not throw out a very large quantity, considering the number and depths of the holes.

Mr. Latrobe says (page 56) that the rapid blow of machine drills tends to heat the bit, and, by injuring its temper, causes it to wear much faster than hand-drills. This appears very plausible; and yet, from my own experiments and the statistics of others, I am satisfied that drills will do more work in a machine, without sharpening, than they will by hand, and, if water be used in both cases, there is *a very great* advantage in favor of machine-drills. In the Report of the Chief Engineer, Mr. Doane, on page 30 of the docu-

ment above referred to, we find that, with hand-labor, for *one foot of advance*, there were 280 drills dulled and 638 inches of hole; and, on page 31, for one foot of advance, with machines, there were 48 drills dulled and 843 inches of hole—showing that, for every foot of advance, it takes $5\frac{8}{10}$ times as many drills by hand as by machines; also, that the machine-drills made $7\frac{8}{10}$ times as many inches as the hand-drills, without sharpening. At the east heading is the only place where both machines and hand-labor have been used, or at least there is no other data in said report from which an exact comparison can be made; but the statistics of the work on the central shaft lead us to infer that similar results might be expected there from the use of machines. At the east heading, hand-drills dulled, on an average, every 2·24 inches, but in the central shaft (p. 35), every 3·30 inches, and, still later (p. 37), 4·51 inches—the last two of which is but little more than half the average by machines. The rock is more easily drilled at the central shaft (p. 62).

It should also be said, in favor of the machine-drills, that the above data is taken from the work of the old machines, which were rejected about the time that the report was made. I was told by the superintendent of the shop, Mr. Hall, that, with the device for holding the drills which was used in that machine, it cost them $20 per day to keep the drills in the machine. The drills would get loose and break, but the device which they now use holds the drills firmly and they have no trouble to keep them in their place, so that the average distance which the drill will cut in the improved machine should be considerably greater than that given above for the old machines. We ought to expect this result. All tools, or rather machines, when properly constructed, do more work than hand tools without sharpening or repairing. As examples, witness the machines for planing, morticing, sawing, nail-cutting, sewing, weaving and mowing. The repairs may cost more when made. I have seen a mowing machine cut acres without sharpening, where the scythe should be sharpened many times, and do more work without repairing than scythe and snath. As a general thing, machines which will not do this cannot compete with hand-labor, and cannot come into general use.

A heavy contract has just been made with Dull & Gowan, the contractors of the Chicago tunnel, involving over a million of dollars. They are to extend the heading at the east end at the rate of 91 feet per month, and enlarge the whole tunnel for over 6000 feet, and sink the central shaft to grade (about 540 feet), at the rate of 30 feet per

month. With these conditions, their contract extends two years. There is also a contract at the west end, but I think that the west shaft is still under the supervision of the State. Should the experiments now being made by Professor Robinson and myself prove successful, we hope to put a machine into the tunnel that will considerably hasten the progress of the work.

DE VOLSON WOOD.

University of Michigan, July, 1867.

THE COMPOSITION OF MORTAR.

THE following communication, which we have just received from Mr. E. F. Moody, is of especial interest, because it serves to correct a statement which has received the sanction of high authority and very general acceptance. Thus, Graham states in his *Chemistry*, p. 408 of the Philadelphia edition, that "The mortar is subject to an ulterior change from the slow absorption of carbonic acid, but even in the oldest mortar the conversion of the hydrate of lime into carbonate is never complete." Similar statements are to be found in many other works.—ED.

PHILADELPHIA, *July 20th*, 1867.

Prof. Henry Morton, Ph.D.

DEAR SIR: Recently a committee of Councils of a neighboring city, contemplated the erection of a large building, and among the materials offered was an artificial stone. The low cost of the article induced the Committee to examine it with great care, and to visit New York where it has been used.

Of course, the principal question was the all-important one of durability, and in order to gain a comparative idea of this, it was necessary to be satisfied as to the true theory of the hardening of compositions of lime and sand, or mortar, whether caused by mechanical or chemical agency. If chemical, the hydrate of lime must slowly absorb carbonic acid from the air, and form carbonate of lime, a material of the requisite stability. I consulted Graham and other leading works, but could not find anything satisfactory. I therefore made the following examinations:

By the first series of experiments, it was proposed to determine whether mortar does or does not absorb carbonic acid. I placed in an appropriate apparatus, one hundred and twenty grains of pulver-

ized mortar from a building* erected about forty years ago, and operated upon it with water and chlorohydric acid, both perfectly pure. Effervescence occurred immediately, and a gas passed over which was mostly absorbed by the cold water of the trough. The same experiment was repeated, the water in the trough heated to about one hundred and seventy degrees, when over fifteen cubic inches of gas was collected, which was proved by all its various reactions to be carbonic acid.

This being perfectly satisfactory, the next series of experiments were arranged to determine the proportional quantity. An ordinary proscription balance was used.

One hundred and twenty grains of the forty year old mortar, dried at two hundred and twelve degrees, was placed in the usual apparatus, the carbonic acid to be absorbed by pure potash; and one hundred and twenty grains of the same ignited in a platinum crucible.

The potash gained	19·1 grains.
Crucible lost	18·5 "
Average	18·8 " carbonic acid.
Equivalent to	42·72 " carbonate of lime.
Which is	35·6 per cent of the whole.
Or	87·3 " " of the dissolved matter.

The same quantities of another mortar, at least eighty years old, were treated in the same manner.

Potash gained	17·2 grains.
Crucible lost	16·5 "
Average	16·85 " carbonic acid.
Equivalent to	38·3 " of carbonate of lime.
Which would be	31·9 per cent. of the total amount.

The quantity of soluble matter in this case was not estimated.

Another very old mortar was examined, upon the same basis, with the following results:

Potash gain	15 grains.
Crucible loss	18 × "

From speculating upon the cause of so large a difference, I was led to examine the residue. The iron was found to have existed originally as sesquioxide, and it was recovered in that form. I failed to find any trace of silicic acid in the filtrate, and thence conclude

* This mortar was not scraped from the exterior, but removed bodily from between the stones.

that no silicate had been formed from the decomposition of the sand, soluble in boiling chlorohydric acid; but I did separate from the lime a considerable precipitate of magnesia. The fact that hydrate of magnesia parts with its combined water only at a red heat, will, I think, explain the loss. Under this view, 3 grains of water are equivalent to 9·66 grains of hydrate of magnesia; 15 grains carbonic acid are equivalent to 34·09 grains of carbonate of lime. The ignited sesquioxide of iron weighed one grain, and the undissolved sand, &c., weighed 75·5 grains; from which data the following may be calculated:

	Grains.	Per cent. of whole amount.	Per cent. of dissolved matter.
Sand, &c	75·50	62·91	
Carbonate of lime	34·09	28·40	76·60
Hydrate magnesia	9·66	8·05	21·70
Oxide of iron	1·	·83	2·27
	120·25	100·19	100·57

From this it may be inferred that, in this instance, in the course of a century, all the lime had been converted into carbonate, while the magnesia still remained as hydrate. From the small proportion of magnesia in comparison with the dolomites, it may be easily supposed that magnesia and pure lime were mixed accidently in the lime yard previous to use, as would naturally be the case when purchased from different sources, and heaped together. It may be possible that a somewhat large proportion of hydrate of magnesia might almost or entirely prevent the formation of carbonate of lime, and thus explain the variety of opinion in regard to the subject.

For lime-burning, some of the dolomites enjoy at the present time the highest reputation in the market, on account of their economical value; yet if the above suggestions should be verified by accurate analysis, they cannot fail to have bearing upon the selection of limestone for the manufacture of lime.

Very respectfully, I am, &c.,

EDWARD F. MOODY, A.M.

Civil and Mechanical Engineering.

(Continued from page 27.)

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

CHAPTER III.—Continued.

THE amount of practicable compression was found to be about fifteen per cent. of the original bulk of the stones as they were first loosely spread on the road.* Beyond this no good result was obtained by continuing the rolling, but a positive injury. The entire body of stones, on the section of road upon which the experiment was tried, was settled into the ground by the excessive rolling, and the road-bed, *which had previously been made very firm*, was impaired, and the side-gutters deranged, pressed outward and upward by the operation. The trial having shown that some extraneous material was absolutely necessary to intermix with the broken stones to aid in perfecting the binding principle, such a material was sought for from available sources as was considered best adapted to the purpose and least deleterious to the road. Loam, sand, gravel and the detritus from stone quarries and from the sites where stone had been broken for the roads, were severally considered. Some road-makers (French) have used loam and sand, and have not hesitated to recommend even dirt, or inferior debris; but this material—while it would facilitate and hasten the packing and binding process—was believed to be, in the end, injurious to the road. Clean, hard gravel was considered the safest material, and it was practicable to procure it in sufficient quantity, the only doubt being as to its efficient binding properties. It was accordingly tried, and was spread over and intermixed with the surface layer of the broken stone by shovels and rakes after the layer had been first moderately rolled. From one to two inches in depth of gravel was used. The surface was kept properly moistened, and the rolling was continued, with the heavy roller (reduced to its original weight of 6½ tons), and a successful result was soon manifest. The gravel worked down and filled the interstices of the stone, the

* This, it will be observed, relates to the *very hard* stones. The softer gneiss stones were found to compress eighteen to twenty per cent.

coarser particles filling the larger cavities and the finer the smaller ones, surrounding and steadying the stones in their places, until all were compressed by the weight of the roller into a solid mass. Some portions of the gravel are necessarily crushed in the operation, and the sand and dust contribute to the cohesion, but the quantity is comparatively small and it has not the objectionable character of loam or dirt.

The road surfaces finished in this way are even and smooth, and the broken stones lie firmly in their places, becoming more rigidly bound by use.

The gravel at first—after the discontinuance of the rolling—appears to cover the surface of the road, nearly or quite concealing the stones; but little of it, however, really remains on the surface, and this is soon worked into the interstices by the travel, or is reduced to sand or dust and carried off by rains.

After the wearing away or gradual displacement of the portions of gravel that are held in the angular surface cavities between the stones, the stones begin to receive the full service to which the roads are subjected. In this condition they remain firm in their places for a longer or shorter time, according to the amount of wear they receive and the attention that is given to repairs. The first evidence of deterioration is the loosening and slipping out here and there of isolated stones, and this tendency is very much increased by neglect in watering the roads in dry and hot weather, and also by the action of severe frost.

While the surface of the road remains coated lightly with gravel, or a sufficient amount of it remains to prevent the stones from becoming prominent, it is agreeable to travel on in fair weather, and, excepting a harsh gritty sound of carriage-wheels, it would compare, not unfavorably, with the gravel road hereafter described. But when the stones become entirely bared, the asperities are such as to cause a constant succession of short jolts, giving an unpleasant sensation to the occupants of carriages, and the noise produced by the wheels and clatter of horses' feet on the rigid stones is far from agreeable to those who drive for pleasure.

Such a road, however, for ordinary highway purposes, would be held to be, under its least perfect conditions of surface, quite a substantial and seviceable road, and it would be in fact, as compared with the average roads of the country, fully entitled to such commendation; indeed, if the public had no knowledge of a still better description

of road, they would doubtless be content to use it for pleasure travel, and would tolerate, without much complaint, its unpleasant features.

I mention here the fact—subsequently developed—that upon the completion of the first piece of gravel road that was made in the Park, the public soon evinced a preference for it over the MacAdam and Telford roads, and after its qualities were tested by a few months' use, the dislike to the MacAdam and Telford roads became so unmistakeable, that measures were taken to convert the portions of those roads that were then made into gravel roads. Upon this subject some further remarks may hereafter be made under the head of *Repairs of Roads.*

2d. *The Telford Road.*—Telford roads, as has before been explained, were the invention of Thomas Telford. He devised the plan of forming a sub-pavement of rough quarry stones to underlie the usual road material and perfect the foundation. The plan was soon demonstrated, by practical results, to be an improvement over the MacAdam and other methods, and it took the name, which it has since retained, of the Telford road. Its advantages are, a better mechanical disposition of materials than had previously prevailed, greater stability, and at the same time greater economy in construction. Such advantages combined could not fail to be appreciated, and to constitute an important advance in the art of road-making.

Upon the top of the stone pavement, Telford placed broken stones similar in kind, quality and sizes to those used in the MacAdam road. The layer of broken stones was about six inches thick, and, when the work was complete, the external appearance of the road was the same as that of the MacAdam road. So far as the immediate results of surface wear and ease of traction were concerned, no superiority was claimed over the MacAdam road,* the aim being not so much to make a road with an improved or more highly-finished surface, as to perfect, in a practical way, the foundation and adapt it to heavy and lasting service, a result that was successfully attained.

Proceeding upon the general idea that was originated by Telford, a portion of the Park roads was constructed in the following manner:

1st. *The Sub-pavement.*—Plate II., page 304.—Sound stones were selected from the gniess rock excavations of the Park for this part of the work, such as were too large being broken up to the proper sizes.

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* PARNELL, who is very strong and decided in his objections to the MacAdam road, estimates the cost of repairs of a Telford road at fifteen to twenty-five per cent. *less* than a MacAdam road.

Men were specially selected for this particular duty, as a considerable degree of skill is required in the use of the hammer to give the stones the desired shape without unnecessary labor and waste of material. The stones were required to be, generally, from seven to ten inches deep, three to six inches thick, and not greater in length than about twice their depth. Parallel-sided stones were sought as far as practicable, but stones more or less wedge-shaped were necessarily admitted. The stones were deposited on the road-bed—after it had been thoroughly prepared, as heretofore described—in convenient position and quantities for use; they were then taken in hand by men who (as far as such could be selected from the laboring gangs) had had some experience in paving work, and were set on edge, ranging crosswise of the road, *with their broadest edges down*, and compactly together. After a section of pavement of some extent had been formed in this way, a smaller squad of men followed, whose duty it was, by means of iron bars, properly formed—the lower end being chisel-shaped and the upper end having an enlargement or knob to use as rammer—to pry open and force apart all stones in the pavement presenting the largest interstices, and to insert and drive down, in such places, other stones of the *same depth*. The best hard, tough and suitably shaped stones were selected for this purpose. The men followed the range of the stones as set crosswise of the road, forward and backward, feeling carefully with their bars for all stones that were loose, and looking out for all cavities that needed wedges or binding-stones, and every such case was thoroughly attended to in the manner stated. By this means all the stones in the pavement were compressed together to the greatest practicable extent, and each one was firmly bound in the mass and made to perform its duty. After this, other men followed with light hammers, and filled in with smaller stones (hard wedge-shaped spalls selected for the purpose) the more superficial cavities and inequalities of the pavement; the projecting points of the paving stones were, during the same process, knocked off, and the chips worked into the remaining interstices. Men of ordinary intelligence soon acquired with proper instruction, the necessary expertness to perform these several duties. Care was nevertheless necessary to prevent them from exercising *too much strength* upon the stones and splitting or crushing them. After the work had been all gone over in this way,

Fig. 3.

Fig. 4.

it was closely inspected, and any weak places or improper work (not unfrequently found) were corrected.

By trimming off the projecting points of the paving stones, the depth of the pavement was reduced to seven or eight inches; the wedging and filling in with stone chips brought up the depressions so that, when all was done, the pavement had an even and close surface. It presented, in fact, at this stage of the work, a surface nearly as inviting to travel on as that of an ordinary MacAdam road, and one that would have improved somewhat with use and would also have withstood a good deal of service.

2d. *The Broken Stone Covering.*—The broken stone made use of—above the sub-pavement—to complete the road, was chiefly the product of the hard and tenacious boulders of the Park. In some cases this kind of stone was economized, in the same way as in the MacAdam road, by using, in the bottom of the layer, a portion of the less valuable and more easily broken stone from the gneiss rock excavations, the surface of the layer only being completed with the boulder stone.

The stones were broken to the same sizes—two and a half inches in their largest dimensions—as in the case of the MacAdam roads, and the same care was taken to keep them free from dirt and detritus, by the use of pronged shovels, in taking them from the ground, where they had been broken or deposited, and loading them into carts or wheelbarrows. They were first spread over the pavement in a light layer, and then rolled with the lighter rollers, all necessary precautions being taken to prevent injury to the pavement during the first stages of the rolling.

The stones were kept properly moistened by sprinkling carts, as no rolling can be done effectively while the stones are dry.

The second course, which was usually the final course, was put on and treated, in all respects, in the same manner as the final course on the MacAdam roads, clean, hard gravel being intermixed with the stones by spreading it over the surface, and all being thoroughly rolled, first with the lighter roller and next, and lastly, with the large heavy roller.

The depth of the broken stones, when fully compacted, was about five inches.

The road-bed having been, at first, shaped in accordance with the intended crowning form of the road surface when finished, the pavement and the covering of broken stone were successively formed with

corresponding curved surfaces, preserving an equal thickness of each throughout from the sides to the centre of the roadway. Where any irregularities occurred in depositing the broken stone, affecting this arrangement, it was immediately corrected by men skilled in raking and shifting the materials, so that the final surface resulted in a true transverse curve that would bear the test of a profile board that was occasionally applied as a guide or check to the work. The same pains were taken to preserve an even and true longitudinal surface of the road, and prevent the formation of swells and hollows or undulations—such as are apt to degenerate, sooner or later, into what are termed, in road parlance, "cradles," which are destructive to the character of a road having any pretensions to respectability.

The Telford roads constructed in this way, have proved that they possess all the stable qualities attributed to them. They retain, in a very noticeable manner, under service and through all changes of weather and extremes of temperature, the uniform evenness of surface given them in construction. In comparison with the MacAdam roads, in this respect, they are decidedly superior. With equal amounts of material in the two cases, the Telford arrangement is demonstrably that which produces the best results. The reasons for this are obvious. The strong stone pavement distributes widely the pressure brought upon any given point, and it is therefore but lightly felt, and causes no disturbing action or movement of the materials. The arrangement of the paving stones, set crosswise of the road, with abundant cavities between them, is favorable to the drainage, and this is an important element in the durability of the work.

The Telford road is, of course, open to the same objection as to asperities and rigidity of surface as the MacAdam road. This affects the agreeableness of both kinds of road, and renders them alike less desirable than gravel roads for pleasure travel; but in all other respects—for the general purposes of "common roads,"—the superiority of the Telford over the MacAdam form of construction is unquestionable. This applies not only to the stability of the work but to facilities of construction and to immediate economy. The advantages in these respects have been heretofore shown (in the case of the samples of the two kinds of road that were first constructed) to be as 1·50 to 1·75 in favor of the Telford road.* Besides, stone

* This ratio is liable to considerable variation; as a general rule, it is believed to be here understated on the side of the Telford road. It will be observed that the estimate was based upon the use of a steam-power machine in breaking the stone. Parnell states the ratio, in the case of a Telford road, 12 inches deep and 16 feet wide, and that of a MacAdam road, 10 inches deep and 16 feet wide, as 1·50 to 1·87.

may be used in the formation of the pavement that would not be suitable for breaking up for MacAdam roads.

It is to be remarked, that Telford's plan of forming the pavement was to place it on a level surface of ground transversely of the road, and to give the crowning surface to the pavement by an additional depth of the paving stones in the middle of the road over those at the sides. For a road of thirty feet in width, he used stones of seven inches in depth in the middle of the road, tapering off so as to give a curved surface, to three inches depth at the sides. This form, after giving due consideration to it, and hesitating to differ from so distinguished an authority, was considered less advantageous than the one that was adopted, as has been described. The level surface of the road-bed was not so well adapted to drainage, and no reason could be seen for giving the stones less depth at the sides of the road than in the middle (aside from the object of producing the crowning form on a level bed), as the service is distributed over all nearly alike, and a thickness of pavement reduced as low as three inches at the sides was believed to be too light for effective construction or service. The only compensation for such an arrangement seemed to be in the somewhat greater facility of obtaining stones of irregular sizes, instead of being restricted to such as had greater uniformity in this respect, but this was regarded as more than balanced by the convenience as well as utility of using the latter kind of stones in the work.

The broken stones above the pavement were spread an equal thickness, by Telford, over the entire surface, as has been done on the Park roads, the depth being about six inches. The crown of his roads, of thirty feet in width, was four to six inches above the sides. The MacAdam and Telford roads of the Park, of forty-five feet width, are crowned six inches.

Stone-Breaking Machine.—Inquiries have frequently been made, during and since the construction of the MacAdam and Telford roads of the Park, as to the cost and facilities of procuring broken stone, with reference to other roads, and also with reference to the use of the stone in forming concrete in the foundations and other parts of engineering works.

Such inquiries have been answered by communicating such information as was conveniently at hand at the time. But in order to give the fullest information practicable upon this subject, reference is here made to a stone-breaking machine that was employed in breaking stones on the Park, a drawing of which, with some other details, will hereafter be given.

A large quantity of stone was broken by this machine (under a contract with the proprietor), and the results were satisfactory, and demonstrated it to be a valuable labor-saving machine wherever a large amount of work is required to be done.

It is capable, if well tended, of turning out broken stones, of an ordinary degree of hardness, at twenty-five to thirty per cent. less cost than they can be produced by hand-labor.

It will break, with equal facility, the hardest trap stone and granite, gneiss, limestone and sandstone; but in the case of the harder stone, the additional cost of preparing the blocks for reception by the machine (in sizes of about half a cubic foot each, the size depending somewhat upon the shape of the stone), increases the relative cost of the product, which, however, is still obtained at less cost than the same kind by hand labor.

A great convenience of the operation is the separation, by means of attached screens, of the coarse from the fine stones, and also the sifting out from each kind of all dirt and dust.

A machine, driven by steam, upon a different principle as to crushing power, was introduced upon the Park by another party, but was not as successful as this one. It was not so well adapted for breaking very hard stone, and was withdrawn after breaking, by contract, about one thousand cubic yards of stone.

(To be continued.)

From the London Mechanics' Magazine, April, 1867.

THE MONT CENIS TUNNEL.

THE following particulars concerning the present state of the works in the tunnel of Mont Cenis are gleaned from the *Journal de Savoie*. The excavations had been for the last two years delayed on the French slope by a vein of quartz, which did not admit of an advance of more than from two feet to two and a half feet a day. That layer has now been got through; and one of much softer stone having succeeded, the perforating machines are able to accomplish double that distance each day. In a short time, when certain improvements shall have been effected in the machinery, from six feet to seven feet will be perforated every twenty-four hours. After the section now worked, a portion of schist, equally friable, will be entered on, and this has already been reached on the Italian side. The united progress will then amount to a total of thirteen feet per diem, and in four years the tunnel will be completed. In the meantime, the English company of

Mr. Fell is actively pursuing for the State the restoration of the Imperial road between St. Michael and Modane, which was carried off on several points, as may be remembered, by an inundation of the Arc in Autumn last. More than fifteen hundred men are employed on that work. The same firm is also proceeding with the railway over Mont Cenis, which it hopes to be able to open for traffic before the end of the present year.

From the London Mechanics' Magazine, May, 1867.

OVERHEATED STEAM-BOILERS.

MUCH has been said and written to prove that there is no fear of a violent explosion being produced by turning on the feed into an empty boiler, with the plates even red hot. Experiments are also on record which have been instituted to prove the same thing. But notwithstanding the clearness of theoretical deductions and the self-evident nature of practical results, the opinion still obtains with some that the danger in such a case is immediate, and a disaster a matter of moral certainty. We treated this subject both theoretically and practically in our issue for November 16, last year, and the views then expressed have been since endorsed by practical men. But on the other hand there are those who have attempted to refute them, and who, although silenced, have expressed themselves as not having been convinced. Had they even been convinced, if against their wills, they would not have been convinced at all. In order, therefore, to clear away the misapprehensions which still exist in some minds, and the doubts which still lurk in others, we purpose placing before our readers the particulars of a few practical experiments which were recently made to test the point in question. They were conducted by Mr. L. E. Fletcher, the chief engineer of the Manchester Boiler Association, and the results clearly show that the danger of injecting water into red-hot boilers has been greatly exaggerated. The experiments were carried out at the works of Messrs. Isaac Storey & Son, of Manchester, who provided Mr. Fletcher, at their own expense, with three boilers, at the same time affording the assistance of their workmen, with all the necessary appliances and the convenience of their works. This practical investigation was mainly due to the numerous household boiler explosions which took place during last winter. But as the question involved is one of very general importance, relating not only to the safety of household boilers, but also to the explanations so frequently given of the cause of explosions occurring to large steam-power boilers, the following details of the experiments will be interesting to our readers.

The boilers experimented on were three in number, and were all of the ordinary household circulating class. The first of these boilers

was made of copper, weighed sixty-two pounds, and measured fourteen and three-fourths inches in height, eleven and three-fourths inches in width, by thirteen and one-fourth inches in depth at the bottom, and about eight inches at the top, which gave an internal capacity of about one cubic foot. This was placed, empty, on the top of a brisk fire, as well as surrounded with it, and allowed to remain so till the bottom became red-hot, and lumps of lead freely melted, though but loosely laid on the top, which was the coldest part of the boiler, being out of the reach of the flames. Under these conditions water was suddenly let into it through a one-half inch pipe. No explosion, however, took place, the boiler was not stirred from its seat, neither did it tremble or evince the slightest sign of internal emotion; all that took place was a rush of steam through an outlet seven-eighths of an inch in diameter, left on the top of the boiler. It was necessary to have this opening, or the water would not have found its way into the boiler at all, as was proved by actual experiment with it closed, when the first puff of steam generated forbade the entry of more water. This opening, however, could in no way have assisted to prevent the bursting of the boiler, if the views entertained with regard to the explosive effect of dashing water on red-hot plates were correct. The action of the water under these circumstances is supposed to be as irresistable and instantaneous as that of gunpowder. The result of this experiment was considered conclusive, but it was thought to be more satisfactory to repeat it with another boiler of slightly different dimensions by way of corroboration. The second boiler, which was also copper, weighed forty-four pounds, and measured eleven and three-fourths inches in height, eleven and a half inches in width, by ten and a half inches in depth at the bottom, and eight and a half inches at the top, having a flue tube running through it six inches in diameter, so that it had an internal capacity of about five-eighths of a cubic foot. This boiler was surrounded, just as the previous one had been, by a brisk fire, which operated not only on the bottom and sides, but also on the internal flue tube. It was allowed to remain perfectly empty, until lead, loosely laid on the top, freely melted, and nearly half of the boiler became red-hot. Water was then suddenly turned into it through an inch pipe, which was connected to the boiler at one end and to a tank affording a head of from six to eight feet in height at the other. It was supposed that an increased diameter of pipe would give a more sudden injection of water, and therefore prove more favorable to an instantaneous injection of steam. The result, however, was the same as in the previous experiment; there was no explosion—the boiler remained perfectly still, the only effect produced being the escape of a jet of steam through a hole in the top of the boiler, left for the purpose.

Here, then, was a complete corroboration of the first experiment; both being thoroughly convincing as far as they went. But they were both conducted in boilers made of copper, whereas many in use

for household purposes are made of cast iron. The experiment was therefore repeated with a cast iron boiler, which would possibly prove more favorable to explosion, as well on account of the brittleness of the material as from its greater weight of metal, which would afford increased capacity for heat, and thus for the more rapid generation of steam. This third boiler weighed eighty-five pounds and measured fifteen and a fourth inches in length, ten inches in height, by eleven and a half inches in depth at the bottom, and eight and a fourth inches at the top, having an internal capacity of less than a cubic foot, while the bottom was arched, which increased the heating surface. This boiler, like the previous ones, was heated till the greater part of it became red-hot, and lead melted on the top. Indeed, it was in such a glowing heat that it appeared on looking into it through a small orifice as if the bottom had been burnt out, and the eye was looking directly into the fire itself. Water was then laid on by means of a pipe one inch in diameter, connecting the boiler to a tank giving a head of from six to eight feet, but there was no orifice left open on the top of the boiler as before, a safety-valve, loaded to a pressure of about thirty-five pounds on the square inch, being substituted. On opening the tap in the connecting pipe, and letting the water on, no result whatever was apparent. The safety-valve did not blow, and the boiler neither cracked nor trembled, but the feed-pipe was found to get hot up to the tap, some fifteen feet from the boiler, as if the steam was beating back and forbiding further entry of the water. After allowing the boiler to rest in this position for some time, with the fire briskly burning around it, the safety-valve was lifted, when a very moderate escape of steam took place, and continued as long as the valve was kept open, but ceased as soon as it was allowed to fall. Finding that no result could be produced with the safety-valve attached to the boiler, it was removed, and an orifice one and a fourth inch in diameter left open instead. On turning the water on again, a jet of steam escaped from the orifice as before, and shortly after the boiler cracked on one side from the top to the bottom with a sharp report. This was due simply to the contraction of the metal, and the rupture did not spread, neither did the boiler stir from its seat. The water was kept on till the boiler was filled, but no result followed different to those already described. In order to render the experiment as conclusive as possible, the last one was repeated for corroboration. The boiler was emptied and replaced on the fire, the connections were made as before, but the safety-valve was taken off and the diameter of the opening on the top was reduced to three-eighths of an inch. The water was again turned on and the result was just as before. A jet of steam issued from the orifice on the top of the boiler in a constant stream as long as the feed tap was kept open, and intermittently when it was opened and closed alternately. The capacity of these boilers was such that a pressure of about one hundred and fifty pounds on the square inch would have been generated within them by the evaporation of a

quarter of a pint of water in the two larger ones, and an eighth of a pint in the smaller one. Although they were heated all over, it is clear that that pressure could never have been attained or even approached, as the light, flat-sided copper boilers did not bulge in the least, while the rush of steam from the outlet never appeared more than could be taken off by an ordinary safety-valve.

The foregoing experiments prove most conclusively the impossibility of exploding a red-hot boiler by the sudden injection of a stream of cold water. Every endeavor, however, was made to succeed, and everything that glowing red-hot plates and cold water could do under the circumstances was done. Indeed, the test adopted appears to have been much more severe than could occur in ordinary work, either to a household boiler on the occurrence of frost, or to a boiler employed for engine power on the furnaces being over-heated, and the feed suddenly re-admitted to the red-hot plates. In the case of the ordinary household boiler, the fire rarely operates over such an extensive surface as the experimental one. The amount of heated surface was, therefore, far greater in the experiment than it could be in practice. In the case of the steam-boiler for engine purposes, its capacity would be very much larger in comparison with the amount of heated surface exposed on the furnace crowns being laid bare, than in the experimental ones, so that the force of the steam would be proportionally reduced, and so much so in practice as to be completely swallowd up. It may, however, be urged by some that, inasmuch as steam-power boilers are ordinarily constructed of wrought iron plates, and have seams of rivets running along and around them, they were not fairly represented in Mr. Fletcher's experiments. To such as raise this objection we would observe, that an ordinary wrought iron boiler was thus treated some ten years since. The boiler was twenty-fivy feet long and six feet in diameter, the safety-valve was loaded to sixty pounds per square inch, and the empty boiler was then made red-hot, the feed suddenly let in, and the boiler filled up. The only result was a sudden contraction of the over-heated iron, which caused the water to pour out in streams at every seam and rivet as far up as the fire mark extended. Although in each case the experimenters failed to explode the boilers, it is to be hoped they have done something towards exploding the theory the experiments were instituted to test. The results may be accepted as conclusive that the idea of explosions arising from the instantaneous generation of a large amount of steam through the injection of water on to hot plates is a fallacy. The metallic plates of a steam-boiler are not capable of containing sufficient heat to change a very large quantity of water into steam. The total quantity of heat which would raise the temperature of one hundred weight of iron through one degree, would impart the same additional temperature to twelve and a half pounds only, of water. The quantity of heat which would raise the temperature of one hundred weight of copper through one degree, would raise that of ten and two-thirds of a pound only, of

water to the same extent. It is clear, then, both theoretically and practically, that overheating is not the cause of violent boiler explosions. And we, therefore, hope that such nonsense will cease to be imported into judicial investigations into the causes of accidents arising from steam-boiler explosions.

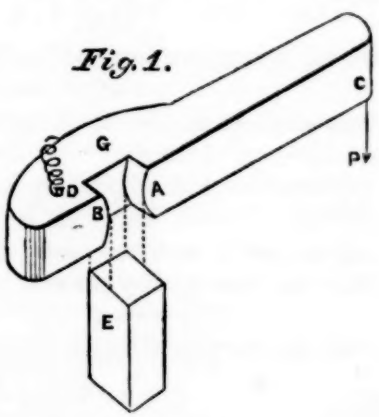
FRICTION GRIPE.

By De Volson Wood, Prof. C. E., University of Michigan.

I have sought in vain for a name for, or analysis of, the device herein described. In practice, I have called it a friction clutch, but it appears that that name has been appropriated for a device of a different character. I therefore propose to use the name at the head of this article, unless a better one is suggested.

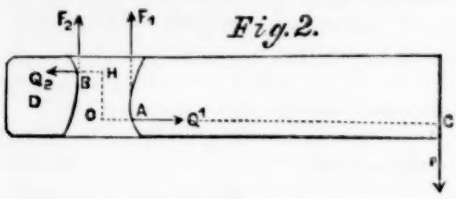
The general form of the "gripe" is shown in Fig. 1. A notch, A B, is made in a piece of metal, so that it may move along the rib, E, when desired. The bearing surfaces, A and B, of the notch are rounded, so that they will not indent the rib in ordinary use. When the gripe is placed upon the rib, the force, P, acting at the end, C, forces the bearing surfaces upon the rib, and, when the parts are properly proportioned, the friction thus developed will prevent the gripe from sliding. If a force act at D, in the same direction as P, and sufficient to overcome the friction, it will move the gripe along; but if it act in the opposite direction, it will cause it to bind more firmly. In practice, a spring, D, is attached to some part of the machine and acts against the gripe so as to cause it to bind; then when the direction of P is reversed, the force, P, and the spring, D, acting together, force the gripe along, the spring keeping the gripe in close contact with the rib, so that, when P is reversed, the gripe will bind upon the rib. In this way, small and instantly it may be, irregular feed movements, have been secured in various machines, such as saw-mills and sewing-machines.

Fig. 1.



The simplest case is when P acts parallel to the rib. Let A and B be the centres of pressure upon the rib. The relation of the parts should be such that the action of P will cause so much friction upon the rib, by pressing A and B upon it, that it will prevent its sliding. Hence, we must have *friction greater than* P. The pressures at A and B are equal, call each Q and f, the co-efficient of friction, and $F^1 = F^2$, the friction which is developed. Then we evidently have

Fig. 2.



$$F_1 = F_2 = fQ, \text{ and } 2F > P, \text{ or } 2fQ > P, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

It is necessary to proportion the parts so as to give this relation. Let O be at the centre of the rib, and O H the longitudinal distance between the centres of pressure, O E = X. Take O as the origin of co-ordinates, and observing that F_1 and F_2 neutralize each other's effect in producing rotation about Q, and we have

$$Q.HO = P.OC \quad \therefore HO = \frac{P}{Q} OC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2.)$$

Or, for security we have, by combining (1) and (2)

$$HO < 2f.\ OC, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3.)$$

from which we see that the relation of C, A and B are independent of the thickness of the rib.

Example.—A steel gripe operates upon a cast iron rib or flange, to which a force of 2000 lbs. is applied, acting parallel to the rib and six inches from the centre of it. The co-efficient of friction is 0·2. Let there be fifty per cent. security. Then (2) gives

$$1{\cdot}50 \times HO = 2 \times 0{\cdot}2 \times 6 \quad \therefore HO = 1{\cdot}6 \text{ inches.}$$

To find the pressure upon the bearing points (2) gives

$$Q = \frac{2000 \times 6}{1{\cdot}6} = 7500 \text{ lbs.}$$

If the notch be $1\frac{1}{2}$ inches deep and the bearing surfaces $\frac{1}{2}$-inch wide, the pressure per square inch will be $7500 \div \frac{3}{4} = 10{,}000$, which, if applied suddenly, will be equivalent to 20,000 lbs. applied gradually. This will not crush cast iron, but it may destroy its elasticity, indent the rib, and soon destroy the working surfaces. To prevent this, the bearing surfaces must be increased. This may be done in several ways. By increasing the depth of the notch, or the width of the

bearing surfaces, *or both*, or by the following device. Gibs, like those shown in Fig. 3, may be inserted between the bearing surfaces of the gripe at the rib. I have never seen these work, but am confident that they can be made to answer a good purpose in heavy machinery. They may be so shaped that, when entered, they will keep their place. The analysis given above shows that the conditions of stability will not be changed by their introduction. The bearing surfaces, A and B, Fig. 2, of the gripe may also be increased, as indicated in Fig. 3. With the gibs, the rib will be less liable to break from cross strain, and hence it may be made lighter than without them.

Fig. 3.

This device appears the more desirable if unguents be used, for then the co-efficient of friction may be reduced to 0·053 for steel upon cast iron, thus making the longitudinal distance between the bearing points in the above example = 0·424 of an inch and the pressure over 28,000 lbs. It is rare that gripes are subjected to such severe strains as I have here supposed. In many machines the applied force is but a few pounds, and others but a few hundred.

When the gripe binds upon the rib, it is in the condition of a beam fixed at one end and loaded at the other, and hence its proper dimensions at the dangerous section are given by the well-known formula

$$Pl = \tfrac{1}{6} R b d^2.$$

In this case, P = 2000 lbs., but call it 4000 lbs. to provide against shocks, l = 6 inches, R = 15,000 lbs., and let b = d = the breadth over the notch, then 6 = 2·1+ inches. The gripe should also be strong enough over the notch to resist Q as a direct pulling force, or considered as acting on a lever. If the direction of P is inclined to the rib, the formulas above must be considerably modified in order to analyze the case.

From the London Engineering, No. 69.

PROPER ARRANGEMENT OF BOLTS AND NUTS.

A WALK through the Paris Exhibition reveals the surprising fact that apparently not one of the exhibitors in the English department, and scarcely any in either of the other departments, understands the action of lock nuts, and therefore the way in which they should be arranged. On every machine in which they are employed, as far as I have been able to observe, a thick and thin nut is employed, and the thin one is placed *outside of the thick one*. Now, suppose two

nuts to be jammed against each other, it is evident that each will be forced equally against the thread of the screw in opposite directions. When an additional external strain comes upon the nuts, it is equally clear that the inner one will be partially or wholly forced away from the thread on which it was previously bearing; and if the external strain is equal to the initial strain put upon the nuts by the act of locking, the inner one will be nearly relieved from pressure on the thread of the bolt, (and would be quite so but for the elasticity of the threads,) and will become merely a distance piece between the pressing body and the outer nut, the pressure on which will meantime have increased. In such a case it is evident that the outside nut does all the work, and in all cases the strain on the outer nut must be greater than on the inner one, and hence it should be the larger of the two. Nothing could be more meaningless than to place a thick nut inside of a thin one.

To my surprise the only engine that I have observed that has these nuts properly arranged (though I trust there are others) is Mr. Corliss', the gibs of his cross-head being sustained in this manner. In the American department, as a rule, no difference is made in the size of the nuts, I presume with the object of saving the labor of turning down the nuts from the size in which they are purchased; but this is certainly better than to turn down one nut and then give it all the work to do, using a thick one to keep it tight.

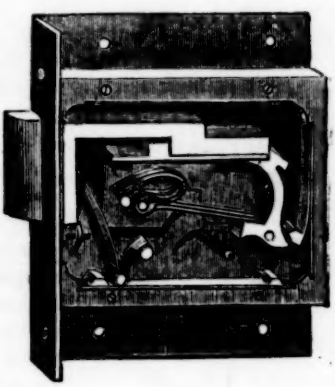
TENACITY OF STEEL RAILS.

At the Chalk Farm Station of the London and North-Western Railway a Bessemer steel rail is now to be seen still in use, and in good order, which has out-lasted twenty-five iron rails successively placed next to it on the same line. Judging by this example, the steel rails are at least twenty-five times as durable as iron ones. Steel rails are very tough, as some experiments made within the last few days at the works of Messrs. John Brown & Co., and Messrs. Cammell & Co., of Sheffield, conclusively illustrate. These experiments were made chiefly for the satisfaction of the Hon. W. J. MacAlpine, formerly engineer of the State of New York, and much connected with railways in America, who contemplates the more extended introduction of steel rails into that country. The result was to show the great toughness and powers of endurance of the steel rails. In one of the experiments a ram of a ton weight was suffered to fall upon a rail of 68 pounds to the yard, supported on iron blocks 3 feet apart in the clear, from a height of 20 feet, and the only effect was to bend the rail. The rail was then turned upside down and the blow repeated, when the rail was bent straight, but without any cracking being visible. Finally, the rail was exposed to the test of a ton ram falling through 30 feet, when the rail was very much bent and twisted, but not a crack was visible. By the mode of manufacture now adopted, perfect uniformity in the composition of the rails is insured.

From the London Engineering, No. 70.

THE NEEDLE LATCH AND LOCK.

We give, with the present notice, a sketch of one form of the "needle" door-lock, which is now being introduced by the Patent Unpickable Lock Company. The object of the company has been to produce a secure yet simple door-lock or latch, which can be manufactured at a cheap rate; and with this view they have substituted for the ordinary tumblers and springs a series of steel wires or needles of the shape shown in the diagram. These needles are strung together upon two stumps attached to the running bolt, and they require to be lifted by the key to such a position as to admit of their being passed through certain holes formed in a brass fence-plate. When they are thus passed, they carry the running bolt with them, and this carries the real bolt. The needles are elastic in themselves, being made of the best steel, thoroughly tempered; and from their position on the stumps this elasticity is increased. Unlike levers, which have only an up and down movement, and which always move to a point direct to the lever stump, the needles are movable obliquely, perpendicularly, laterally, and indeed in any direction; and hence without the key there would be great difficulty in raising all the needles simultaneously to their required positions. This difficulty is increased by a number of false holes being pierced nearly half-way through the fence-plate of the exact size to fit the needles. In the more expensive latches there are protectors and detectors. For instance, No. 3 latch is constructed in such a manner that if an instrument other than its own key is brought into contact with the running bolt, or even raises any one needle higher than its own hole, it upsets the fence-plate, which, on being upset, lays hold of the running bolt, and thus completely prevents any further attempt to unlock. Moreover, in the best locks, by introducing the latch-key, and turning it the reverse way, the lock is thrown out of gear, the needles being set loose, the fence-plate capsized, and the bolt seized. By the introduction of the key, however, and by moving it in the direction of the needles, the fence-plate starts up, the needles are arranged, and with the greatest precision passed each through its own aperture.

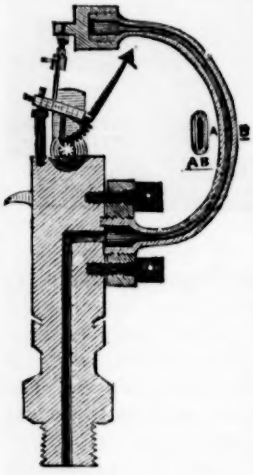


From the London Engineering, No. 42.

HYDRAULIC PRESSURE GAUGE.

The accompanying engraving is an illustration of a hydraulic pressure gauge constructed by the well known firm of Shaeffer & Budenberg, upon Bourdon's principle, modified to suit pressures reaching to five tons per square inch. The majority of our readers are, no doubt, aware that Bourdon's pressure gauge is based upon the property possessed by an elliptical bent tube closed at one of its extremities to uncoil itself when an internal pressure is applied by the medium of some fluid substance, such as water or oil; and the degree of sensitiveness of the instrument depends upon the following two things simultaneously, namely, the length of the coil and the thickness of the metal of the tube.

For very high pressures, such as are transmitted by the hydraulic press, considerably less sensitiveness is required than for steam purposes, and for this reason Messrs. Shaeffer & Budenberg have reduced Bourdon's coil, which has a length of about $\frac{1}{8}$ of a circumference, to half a circumference only, and the tube, which in Bourdon's gauge is made of burnished brass, is in this gauge made of solid steel bored out to the shape shown in cross-section. The loose end is made tight by means of a brass nut screwed upon it, and the joint, with the piece which screws to the hydraulic pump or press, is made good by letting the tube slightly into it. A small connecting rod, articulating in a socket-joint, is attached to the loose end, and communicates motion to the index by means of a small crank, quadrant and pinion; a light hair-spring is attached to the index in order to prevent back lash.



Messrs. Shaeffer & Budenberg have provided these gauges with a contrivance, very simple in its construction, for registering the maximum pressure which has been attained, by means of a loose index which is pushed forward by the principal index, but catches, by means of a small lift, in a kind of ratchet-wheel cut unto the centre of the dial-plate, and, if the gauge is locked, it must remain in the position to which it has been pushed until the person in the possession of the key moves it back.

The fluid used in these gauges for transmitting the pressure is oil, with which the tubes are filled, the advantage of oil being that it does not corrode the tube so readily as water.

These gauges have been applied with complete success, more especially in oil mills, and, among others, at the Copenhagan Mills, at Limehouse, and at Messrs. Blundell & Co.'s mills, at Hull. They are now coming into extensive use.

Mechanics, Physics and Chemistry.

(Continued from page 40.)

LECTURES ON VENTILATION.

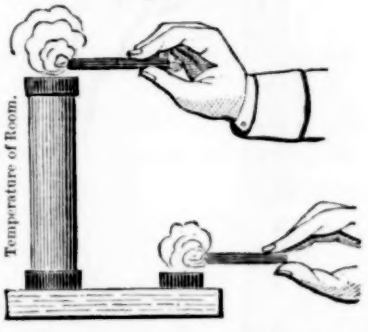
Delivered before the Franklin Institute, by L. W. Leeds, Esq.

LECTURE III—Continued.

In summer, as I have said, the air moves horizontally, and then windows and doors are the great means of ventilation; but as cold weather approaches, we must keep the windows shut, excepting when in bed. In winter, therefore, we must resort to flues for the means of creating a circulation, and for conveying the air from one part to another. A flue is simply a passage—a communication—for air of different temperatures. A flue has no power to *create* a draught. If the air within is colder, it will have the power to fall; if warmer, it will be driven up.

For illustrating this, I have here some glass tubes about two feet long and two inches diameter. This one (Fig. 8) has been lying on the table some time, and I suppose is very nearly the temperature of the air in the room. I have here a little tin box, which answers for a connecting tube, and over one of the openings I stand this tube, and by the smoke from this taper, first held at the top, you see there is no current down the tube. And again, by holding the taper at the lower opening, you see there is no current passing up the flue.

Fig. 8.



But I will remove that, and place one (Fig. 9) over the same opening that is warmer, and now you can see how strongly the smoke is drawn down through this lower opening, and see it flowing up this warm flue, and out at the top.

We will now substitute a cold flue (Fig. 10). This condenses the air, and it falls rapidly. This action often occurs in the spring and early part of summer, especially in the morning, as the external air becomes heated, and the solid mason-work of the chimney remains cold, causing

a descending current, which is often noticeable by the smell of soot in the room. We will now add this tube, of the same temperature as the room (Fig. 11), to see if the additional height will not make an ascending current. But you see the smoke is still drawn down, the

Fig. 9.

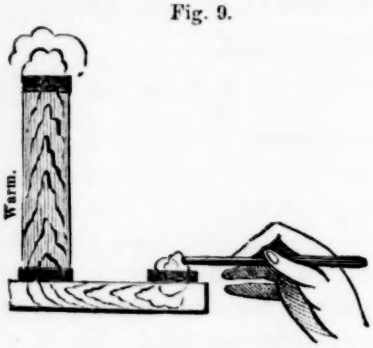


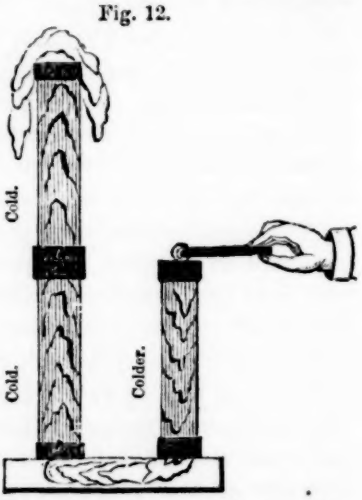
Fig. 10.

height of the flue adds a little to its power, but the difference in its temperature is the controlling force.

We will now place another tube over the lower opening (Fig. 12). Just see what a wonderful effect that has! Here is the air rushing

Fig. 11.

Fig. 12.

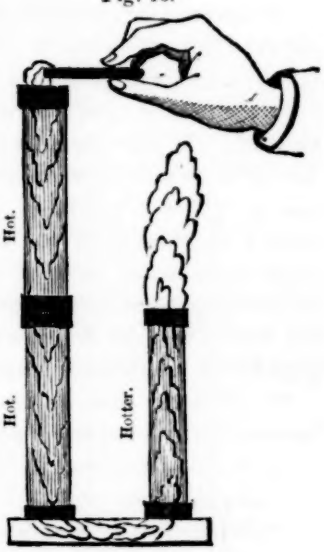


down this short flue and up the two cold ones. We called those two first pipes cold, but our ideas of heat and cold are simply *comparative;* everything is warm, or has heat in it. Perhaps some of us think there is not much heat in the air when it comes whistling around our ears 15° or 20° below zero; but the cold rigid chemist will still

extract many degrees of heat from that. We must, therefore, remember that absolute temperature has nothing to do with the air passing up or down a flue—it is simply *comparative* temperature.

Let me show you one more experiment. Here are two tubes we have had heated; as you see, the smoke rushes up them rapidly. But now we will add this third one (Fig. 13), which reverses the current at once. The two first are hot, taking the *temperature of the room as the standard*, but the third one is still *hotter*.

Fig. 13.



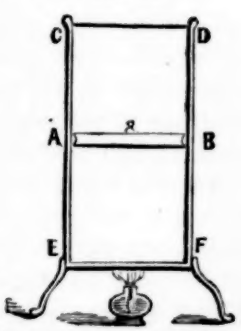
The form of a flue has but little to do with the draught; the height has a slight influence, but bear in mind constantly that the great moving power in all flues is the variation of temperature.

Now, let us make a practical application of this principle.

Wait a moment: just let us lay this one aside, but not forget it, as we shall want to refer to it in a few moments, and try another experiment which has some bearing upon the subject.

I have here a tube just one foot square and two feet long, and one foot from the bottom there is what we will suppose to be an air-tight piston that can be moved without friction. Now, suppose we heat that air 490° (for the sake of easy remembering, say 500°); this would just double its volume—it would then be two cubic feet in size instead of one.

Fig. 14.



Now, suppose that, instead of letting this air expand, we should put a weight on it, so as to keep it in its place, how much do you think we should have to place on? Two thousand one hundred and sixty pounds, or about one ton. Now, what do we find these 2160 pounds to represent? It is the weight of a column of atmosphere with a base of one foot square, or fifteen

pounds multiplied by 144 square inches—it is the weight that would rest upon the piston if all the air was taken out from under it. Therefore, if you add about 500° of heat to a cubic foot of air, it makes it two cubic feet of air; or, if you attempt to keep it from expanding, you must put a ton weight upon it.

Mark one thing, however, if it takes ten ounces of coal to heat that air to 490°, which we do by piling our ton weight upon it, it will take fourteen ounces of coal if we allow it to expand to two feet.

In the former case, where the air remains stationary, it had done no work. It was ready to go to work, but it had not commenced. But in the case of its expansion, it had done a great work. What was it? Why it had lifted that ton of atmospheric air one foot in height, and that work was what used up the difference between ten parts and fourteen parts of coal (I don't trouble you with fractions).

You see, therefore, to make the air quit the earth and ascend into the upper regions, requires a positive power, the same as it does to drive some poor simple people away from the fire on a cold day.

We often say that, by heating air, we give it power to ascend; instead of which heating it destroys its power to maintain its position. It weakens—enervates it—so that its neighbors easily drive it out and take its place.

One cubic foot of air, diluted to two feet, would be driven about two miles and a half high before it found any body as weak as itself, for every 350 feet in height, in round numbers, the pressure diminishes by an amount equal to one degree, or forced under water thirty-four feet reduces it to one-half its bulk.

Now, let us go back and finish our syphon, or flue experiment.

Here we have our little glass house again. We will take the roof off and put a pretty large family in it—I mean large in numbers, if not in size. You may call it a school, or public meeting, or church, or whatever you please. Suppose, for illustration, we call it a church, and we will call this larger light in this end the minister speaking to the congregation. You see, the lights are a good deal agitated, and flare around a good deal.

There is a rush of air down at this end, and, as it becomes heated, it rises at the other. Let us cover about one-half of this up. Now see what a rush of air there is *down* these flues, instead of *up* them, as there ought to be. Here, you see, the main body of the building, though much shorter than the flues, forms the heated leg of the syphon; and you may thus recognize why many of the ventilating

flues, put in the cold outside walls of many of our large buildings, persist in working the wrong way, and cold air blows down there, instead of the foul air going up.

But there seems to be too much draught. Let us put the roof on. Ah, that is better; but, then, what a draught there is down this chimney-flue. Call the janitor, and have that stopped up quickly, or those sitting near there will soon catch their death of cold, and will never come here again.

You see, however, they shine very brightly, notwithstanding all the draught, but there, now, it is all closed up as snugly as the most fashionable church in town. See how quiet and peacefully they burn now!

Ah, there is one just gone to sleep. You must excuse him, he probably was up most of the night with a sick child. Ah, there goes another! I think he must have been very busy for the last week settling up his last year's accounts. Well! well! they are going to sleep so fast, I don't think we can pretend to give excuses for them all.

And, now, is not that a brilliant congregation to be preaching to? Every one dead asleep excepting the preacher himself, and I expect he feels stupid enough to go to sleep, but it would not look well; and he has to tax his energies so severely he will hardly get over it, so as to be good for anything for the balance of the week.

You may think this an exaggerated representation of the real facts. Do not deceive yourselves. A few months since I was requested by one of the congregation to visit a building within a few minutes' walk of this place, and see if there was not some defect in the ventilation. The gentleman stated to me that he sometimes attended the class-meeting, and would be glad to go oftener, but it was held in the basement story, and it was quite impossible for him to keep awake, as he had to get up and go out two or three times during the evening, to get a little fresh air, or he could not keep awake.

I examined it. The ceilings were low—only nine or ten feet—then there were two old leaky portable furnaces, which were used as occasion required for heating the large room above, or the basement room when the class-meeting was held.

The only ventilation they had was to let off the surplus heat (if they had any, which was seldom) into the room above.

Now for fresh air. By a very careful and minute examination, I discovered a little pipe (I think it was about six inches in diameter)

to each stove (both of which would not be over half as large as what I have to supply my own bedroom), for the supply of the fresh air for that whole congregation. *Fresh air*, did I say? Well, let us see where this fresh air comes from. The janitor, after taking us down and showing where he kept the ashes, wood, old benches, and all sorts of rubbish, was about going up, but said I, "Where is the part where you get the fresh air to the furnaces?" "Oh," he said, "he could not get to that, it was such a rough place, and there was a sewer or gutter (from the adjoining graveyard I suppose) running right across it." And from that place, too rough to be got at, with an open sewer running through, and too foul to go into, was where they got the *fresh air* (!) from for the whole of that congregation to breathe.

And do you suppose this is an exception? Let me tell you, during the first year of the late war I was called upon by the Sanitary Commission to examine the hospitals in Washington City with reference to their ventilation. A large number of the churches in that city were used for hospital purposes, and many of them were heated by hot-air furnaces, and in not *one single instance* had they fresh air boxes to them, neither had they any means for carrying off the foul air. The furnaces were generally placed in a hole excavated under the main part of the building, and all the ground around them left exposed, and the air was sucked in from the fermenting, decaying vegetable mould under the building. And this place around the furnace was the place where all the filth and old rubbish was thrown to get it *out of the way*, and it was thoroughly out of the way too, for the surgeon in charge or any inspector never got there to see it. In some cases I found this space around the furnace used as the dead house!

Did I say there was no attempt in any of those buildings for systematic ventilation? I ought to have made one explanation.

I called one morning about ten o'clock at one of the finest new churches, which was then being occupied as a hospital, and asked for the surgeon in charge. He had not arrived. (They did not often venture in before eleven o'clock, the wards became so foul during the night it took till that time, with the windows up, to get them fit for the surgeon in charge to venture in.) I inquired of the wardmaster how the building was ventilated. "Oh, very well—very well, indeed—they had good ventilation," pointing up to a large, splendid ventilator in the ceiling. "Do you keep that always open?" I asked. "Oh, certainly," he replied. But I always have a great suspicion

of those ceiling ventilators, as they are generally shut. So I walked around the ward, and when under it asked him again if he thought that was open. A smile came over his face as he discovered, for the first time, it was a handsome fresco painting on the solid wall. And this was the only practical systematic attempt at any ventilation in any of the church buildings used as hospitals in all Washington.

I have not been in any of the public schools in this city for many years, but a gentleman told me the other day that he called at one of the fashionable schools up town to get his son and take him home under the umbrella, as it had commenced raining since morning, and as he opened the school-room door he was perfectly shocked, as he staggered back from the gust of horrible foul air that came rushing out of that room.

I have examined most of the public schools in New York since I have those of Philadelphia.

They have a way of their own of doing public business over there. There has been a good deal said about ventilating public schools of late years, and as it was such a scientific and fashionable matter they must have their schools ventilated of course.

I was very unfortunate in my intercourse with the Directors of the Public Schools. I did not happen to meet with many of those high-toned, liberal, scientific gentlemen that are on many of the committees of course.

Those beautiful and ornamental gratings called registers are accepted as the external proof of good ventilation, suggesting as they do the flow of an abundance of pure fresh air. So registers were bought freely and put in all the rooms, top and bottom, with splendid red and green and blue tassels, altogether making a handsome show and doing the very able and scientific gentlemen on the School Boards great credit for their enterprise and great care for the welfare and interest of the pupils under their charge.

Now, let us examine the operation of these registers. Holding a handkerchief in front of them, there it remained perfectly motionless. It neither blew hot nor cold—it was perfectly lukewarm, motionless. Go to another—the same. And to another—the same. Well, that is singular. Let us go on the roof and see what can be the matter. A careful search fails to discover any flues at all, but a mechanical examination shows that the capping stone has been put on them, making all the flues as thoroughly air-tight as the solid wall—more perfectly capped than that chimney. There had been no attention

paid to having the holes for the ventilating flues cut through the capping stone.

Yes, I believe that to-day a large proportion of all these flues with the elegant ventilating registers at the top and bottom of the room, are capped and made as thoroughly air-tight as the solid wall, and are as perfect shams and as useless as the elegant frescoed ventilator on the solid wall of the church hospital in Washington.

I do not believe that Philadelphians have gone quite this far in satisfying the public demand for ventilation in the public schools. They may not have *done any more*, but I believe they have not *pretended* to do quite as much.

Excuse me a few minutes; I must illustrate another very great deficiency. The simple illustration I will give you represents almost the universal condition of our hot-air furnaces.

Much complaint was made of the uncomfortable feeling in one of the large public schools, where they had some 1200 or 1500 scholars. I was called to examine it. I asked, as is my usual habit, if they evaporated plenty of water. "Oh, yes; they had given the janitor full directions about keeping the evaporating pans always full." I found the evaporating pans full, sure enough, rather to my surprise, but what do you think they were filled with? Several old brooms, half charred, and some old water-buckets all fallen to pieces, and other rubbish thrown in there *out of the way*.

And now those of you who have been trusting to your servants to keep water in your furnaces, if you will take a candle when you go home and go down and examine your own furnace, you will most likely find it dry, and if you go to the public schools in the morning you will see that they too are not an exception.

I wish I had time to explain the dreadful effect of this want of moisture in all our artificially heated rooms. The air in winter is very dry, the moisture is squeezed out as the water is squeezed out of this sponge. But as you heat it you enlarge its volume again, and it sucks up the moisture just as this sponge does, and if you do not supply this moisture in other ways it will suck the natural moisture from your skin and your lungs, creating that dry, parched, feverish condition so noticeable in our furnace and other stove-heated rooms. Few persons realize the great amount of water necessary to be evaporated to produce the natural condition of moisture corresponding with the increased temperature given the air in many of our rooms in winter.

I have copied a table expressing in grains troy the moisture contained in one cubic foot of air when saturated:

Degrees Fahrenheit.	Grains of vapor in cubic foot.
10	·8
20	1.3
30	2·
40	2·9
50	4·
60	6·
70	8·
80	10·
90	15·
100	19·

(To be continued.)

VENTILATION.

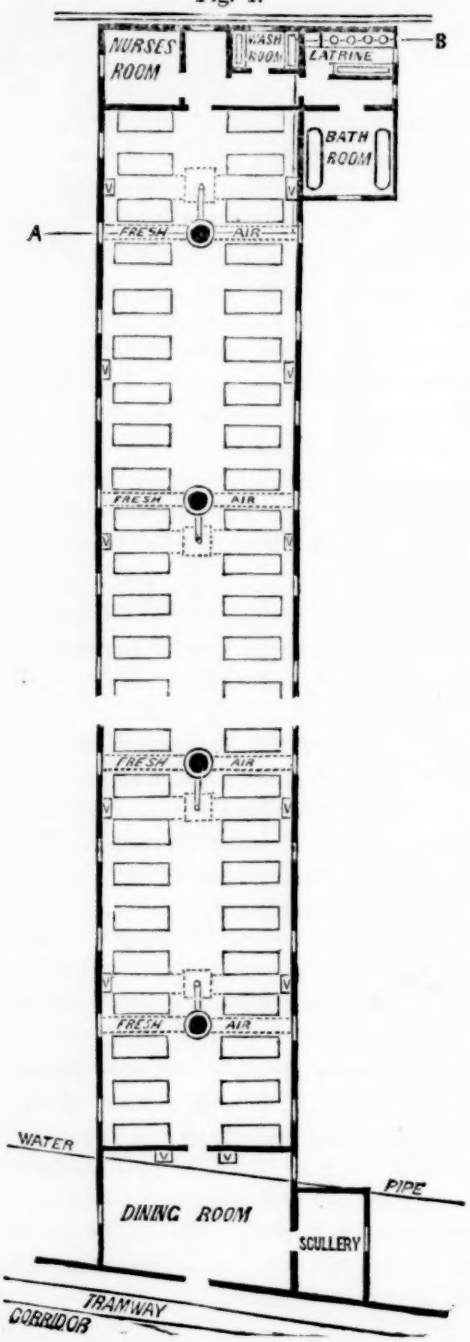
THE GRAND PRIZE AWARDED AT THE PARIS EXHIBITION.

ADDED to the many other gratifying signs of a rapidly increasing interest in the all-important subject of the proper supply of pure air to our houses, is the awarding of the grand prize of the Paris Exhibition to Dr. Evans for an American sanitary collection.

The Sanitary Commission, during our late war, acted upon the principle since expressed by the report of the Board of Health of New York. They say: "And viewing only the causes of preventable diseases and their fatal results, we unhesitatingly state that the very first sanitary want in New York and Brooklyn is VENTILATION —ventilation supplied in all existing tenant-houses, work-rooms, school-rooms and places of assemblage—and in all that shall hereafter be constructed."

The early recognition during the late war, both by the Sanitary Commission and the government officials, of the important fact that many more men are killed by breathing foul air than are killed by the enemies' bullets, led them to use very active exertions to secure good ventilation in hospitals and camps, and to teach the men themselves the value thereof. The result has been highly satisfactory. The fact that we must make some positive provision for a constant supply of fresh air to every occupied room, and not rely on accidental cracks and openings, is now very generally felt. The simple, practical and efficient means used by the government has done much towards creating this wholesome public opinion.

Fig. 1.



The annexed plan (excepting a stove and twelve beds, omitted from centre of plan, indicated by the space) is a copy of one I furnished the Committee, and which was faithfully executed in preparing one of the models of hospitals, the arrangements of which have been so highly appreciated, and has shared one of the grand prizes at the Paris Exhibition:

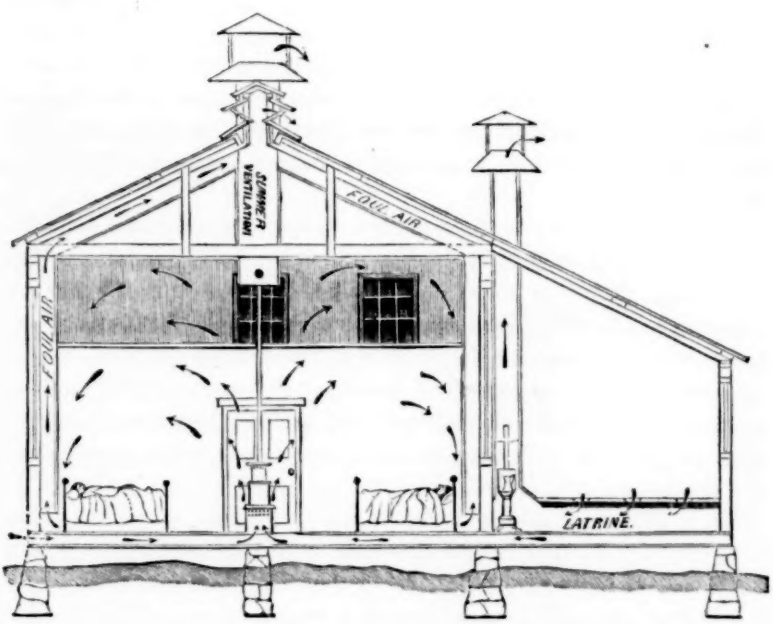
It is a representative plan, showing the general arrangements of wards in a large number of the hospitals.

The special arrangements of flues, v, for winter ventilation, and the introduction of the fresh air around the stove, were not introduced into the hospitals in Philadelphia, built at the commencement of the war. And the subsequent orders of the Surgeon General and Quarter Master General for the introduction thereof were protested against by the Philadelphia Surgeons, owing probably partially to their proverbial objection to changes of any kind, and partially to that dread of "ventilation" made but too popular by the many erroneous

theories which propose to introduce the fresh air directly into the room, and at times, too, when it is even below the freezing point, without first warming it. These arrangements, shown in the accompanying plan and section, were thoroughly tested, however, in many of the hospitals subsequently built in many of the Western cities.

The plan of ridge ventilation, shown in the accompanying section, I applied first in St. Louis, in the summer of 1863. It is the principle of the Emerson ventilator applied to ridge ventilation. Much trouble had been experienced with other forms on account of their

Fig. 2.



allowing the storms to beat in and the difficulty of opening and closing them with the various changes of wind; this form fully remedies those objections, and can be left open without inconvenience at all times while snowing or raining. It uses the force of the wind whenever there is a current passing over the top of the building for sucking the air out of the ward, because the air in passing across the top of the building is deflected from the straight line by the angle of the roof-board, which creates a partial vacuum in the space below, which, with the friction of the passing current with that coming out of the ward,

makes an outward draught, varying in proportion to the velocity of the external current. This is often very useful, especially in summer, when there is not sufficient difference between the external air and that in the ward to create a current. There is often a considerable force in the passing current at the top of the building when there is much less below.

But of course these openings had to be closed in winter to prevent all the heat from escaping. It then became necessary in wards that had no fireplaces, to make something as substitutes therefor. Wooden shafts or flues were made to answer this purpose.

I at first made large wooden boxes, placing them in the centre of the wards, and allowing them to extend down to within twelve or eighteen inches of the floor. This was of great advantage, but as the true principle of ventilation is to have an opening for the exit of the contaminated air at the feet of each occupant of a room, or at the head of the bed of each patient in a hospital, it was soon observed that these shafts were too few and far between to make a very perfect arrangement.

The necessity for providing for the escape of the foul air from the level of the floor in winter, so as to utilize the heat, was, after much opposition, finally established and officially acknowledged by the government officers. Then arrangements were made for its introduction into the government hospitals in a more perfect manner.

I believe in no case, however, was it so fully carried out as to place a ventilating flue between each bed, but in some they were arranged, as shown (marked V) in the accompanying plans between every other two beds.

These flues were carried together and extended through the ridge of the roof and capped as an Emerson ventilator; the opening into the large flue extending to just below the ceiling was closed in winter at all times, excepting when the room was too warm. This was for the exhaust, but of no less importance was the supply.

The popular dread of ventilation arises in a great measure from the supposition that good ventilation implies a strong draught of cold air upon your back or feet or some other unfortunately exposed place. This unfortunate supposition must be fully remedied in any system of ventilation before it can become popular.

As the simplest way of getting at this, all the fresh air required to supply the partial vacuum created by the exhausting shafts was brought in, around the stoves, and partially warmed before entering.

At the first the stoves were entirely encased, and the fresh air allowed to encircle them completely, but experience soon demonstrated the desirableness of having a portion of the hot stove exposed for direct radiation, so that the feeble and chilly ones might come near to it and warm themselves. There should always be a considerable amount of direct radiation in every hospital; that from an open fire is the best, but that from a stove or steam-pipe is very good.

Arrangements were also made for the evaporation of a large amount of water.

As the first winter approached after the commencement of the war, the idea seemed almost shocking to me of putting the sick and wounded men in such open barracks, generally without plastering, and made, as many of them were, with rough boards and very open.

But experience soon taught me the very great superiority of these light and airy buildings over many of the elaborately finished, dark, air-tight structures, such as hotels, colleges, new-fashioned asylums, &c., which the government was compelled to take for hospital purposes.

In fact, when completed with the ventilation as above described, with the abundant sunlight on both sides, without any obstructing partitions and abundantly warmed in winter, and with the proper supply of moisture, they made undoubtedly the most comfortable and wholesome class of buildings, as a whole, that have ever been erected for hospital purposes, not excepting even many of the recent elaborately finished buildings, where not unfrequently too much dependence has been placed on the very meagre and insufficient effect produced by attempts at artificial ventilation, instead of relying more upon the great natural means of ventilation—an abundance of large open windows, open fires and good ventilating stoves.

The ventilation of the latrines or water-closets of a hospital, as well as any other place, is a matter of great importance.

In the spring of 1863, I had put up in a hospital in Washington a ventilating shaft for the latrine room, similar to the one shown on the plans. This was an experiment, but it proved so satisfactory that it was subsequently ordered to be applied in all the principal hospitals.

The difficulty in the isolated wards was, that it required a separate fire in each shaft in the summer. Where it is possible to get it near the kitchen or bake-oven fire, that answers a splendid purpose; but in the single wards it is not necessary to keep up a constant fire;

a few sticks of wood every morning answers the purpose of keeping the air in the shaft warmer than the surrounding atmosphere, which, of course, creates the proper draught.

These shafts were made very large—never less than thirty inches square and sometimes three feet by six feet. The popular plan of opening the water-closet windows and allowing much of the fresh air to enter the building that way was strenuously avoided; the windows in the closet were fastened shut, and then the air to supply this large exhaust shaft was drawn from the adjoining ward or room, which ventilated that ward and prevented any unpleasant odor from the closets returning into the ward.

Wherever it was possible, a sheet iron or cast iron pipe was carried up into the centre of this shaft from the kitchen, laundry, bakery or any other constant fire, and where no heat from a permanent fire or from a steam coil could be obtained, a small stove for the purpose was provided.

LEWIS W. LEEDS,
Germantown, Pa.

7th mo. 26th, 1867.

From the London Mechanics' Magazine, June, 1867.

THE SILVER MINT OF JAPAN.

AT the silver mint at Yeddo the following processes are continually going on: A lump of silver of the necessary fineness, obtained either from the government mines or by melting down Mexican dollars, is placed in an iron ladle and reduced to a molten state by means of a charcoal fire and a pair of blacksmith's bellows. It is then poured into a mould, from which it is taken out in the shape of thin rectangular bars, which are immediately thrown into a tub of cold water. On being taken out a man seated on the ground shears off with a pair of large fixed scissors all jagged pieces adhering to the angles. They are now handed to another man, who weighs them one by one, and a piece is cut off, if necessary, to reduce the bar to its proper weight. The next process is that of dividing the bar by a fixed pair of shears into eight equal portions of the size of ichibus; this is done by a workman cutting it as accurately as his practised eye will enable him, and his work is tested by weighing, light pieces being rejected, and the heavy ones reduced to their proper weight by the scissors. The pieces are now heated white hot in a charcoal fire, plunged into water, boiled and washed in a kind of brine, from which they come out with a moderately bright surface. They are next very slightly milled on the two sides, and more deeply on the edges, by means of a milled

hammer. They are now ready for stamping. A man places one of the pieces on a stationary die, and lays on the top the other die; a second man, armed with a huge hammer, gives one blow on the upper die, and the coin is struck. The blows are dealt in rapid succession, and the whole scene reminds one of a blacksmith's shop. Boys now punch small stars on the edges by means of chisels and hammers. The coins are weighed one by one for the last time, and the light ones rejected. The imperial stamp is added by means of another stamped chisel and mallet, and the coins are complete. They are rolled up in paper packets of one hundred; each packet is weighed and marked with a seal, which serves as a guarantee of its contents, and gives it currency as one hundred ichibus. While every operation is performed in this primitive manner, perfect order prevails in the establishment; every man goes through his portion of the work in silence and with the regularity of clockwork, and many evince considerable skill. There are about three hundred hands employed in the building. When the men enter in the morning they are made to divest themselves of their own clothes, and put on others belonging to the mint. At the end of the day's work a gong sounds, when the somewhat curious spectacle is presented of three hundred men springing from the ground on which they had been seated, throwing off their clothes, and rushing, a naked throng, to one end of a yard. Here they pass through the following ordeal, in order to prove they have no silver upon them: Their back hair is pulled down and examined, they wash their hands and hold them up to view, they drink water, and then halloa, and, lastly, they run to the other end of the yard clearing two or three hurdles on their way; after which performance they are allowed to put on their own clothes and depart. Mr. Sidney Locock, Her Majesty's secretary of legation, from whose report of this year these statements are taken by the *Times*, believes that the mint has been only twice entered by foreigners, and states that the apparent absence of all restrictions with regard to touching and handling the coins points to the probability that it is not often open to the public; but he remarks that even if it were, the manners and customs of the country are not such as would preclude a mixed assemblage of visitors from going over it and remaining to the end. The quantity of silver being coined daily at the beginning of this year was fifty thousand momme, which, at the rate of 2·3 momme to the ichibu, would give a daily total issue of over twenty-one thousand bus, or about £1500. The whole of these are produced by the simplest manual labor, unaided by a single piece of machinery.

From the London Mechanic's Magazine, June, 1867.

CRYSTALLIZATION OF IRON.

In commenting upon the recent accident at the Blackfriars Bridge works we had occassion to refer to the circumstance that iron becomes crystallized by repeated blows. This theory of a molecular change

in iron from mechanical shocks is with some a disputed point. A circumstance, however, which appears to confirm our views on this subject appears in the American papers. A gentleman possessed a relic of the old revolution in the shape of a French gun-barrel which had been refitted several times with new stocks and locks. After having been fired, probably a million times, it burst and in such a manner that all who saw it pronounced it to have been originally a cast iron barrel. The fractures had all the shortness and crystalline appearance of the metal. But it was pointed out that it was originally of wrought iron, whatever it might seem to be now, for there was the weld plain enough on the under side. The appearance of the metal and its brittle character were, however, sufficient reasons for the hasty conclusions that were originally arrived at. The change in the iron is attributed to the action of the sulphur in the powder, the long use of the gun, and the many times repeated action of concussion.

WATER FURNACE.

REPORT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY ON WHELPLEY AND STORER'S WATER FURNACE.

THE Committee on Chemical Products and Processes, to whom was referred the subject of "Chemical Processes involved in the separation of copper from its ores, in the Water Furnace of Whelpley and Storer," respectfully report—

That Professor Langley appeared before them, and explained, in detail, the chemical reactions on which the process depends. Having been provided with the necessary apparatus and chemicals from the laboratory of the Institute, he demonstrated, by actual experiment, the correctness of his propositions.

It will be remembered, that in this furnace a mixture of atmospheric air, finely pulverized copper ore, and pulverized fuel, is blown downward through a heated space at the top of a vertical tower, and the products of this roasting—consisting, essentially, of the gangue, oxides of copper, oxides of iron, and sulphurous acid—are brought into contact with a mixed solution of chloride of sodium and chloride of calcium, contained in a tank at the foot of the tower. In this solution the oxides of iron are little acted upon, while the sulphurous acid absorbed and the chloride of calcium react on the protoxide of copper, forming dichloride of copper and sulphate of lime, according to the following equation: $2\,CuO + SO_2 + Ca\,Cl\,;\,Na\,Cl = Ca\,O.\,SO_3 + Cu_2\,Cl\,;\,Na\,Cl$. The sulphate of lime is precipitated, while the dichloride of copper is contained in solution by the chloride of sodium. Should the quantity of the chloride of calcium present be insufficient to take up all the oxide of copper, some of the chloride of

sodium will be decomposed, forming dichloride of copper and sulphate of soda; and this sulphate will prove disadvantageous in the subsequent operations. It is therefore important to make sure that there is always an excess of chloride of calcium in the liquor.

Professor Langley stated that dichloride of copper is readily soluble in hot solutions of most chlorides, and even in cold solutions of the alkaline chlorides, and his experiments proved this, so far as chloride of sodium is concerned. It is evident that we have here a generalization and a practical application of the fact observed by Mitscherlich, of the solubility of the double salt, Cu Cl; Na Cl.*

All the copper is, therefore, obtained in solution, and may be separated by decantation from the sediment, consisting of the gangue, oxide of iron and sulphate of lime. The clear copper solution still contains a small proportion of iron, in the form of protochloride, which may be thrown down by adding, while hot, a little precipitated protoxide of copper, one half of which is taken up, while the other half is reduced to dinoxide, and goes down with the iron. The following formula may be supposed to represent the reaction:

$$2\,Fe\,Cl + 4\,Cu\,O = Fe_2O_3 + Cu_2O \ldots + 2\,Cu\,Cl.$$

This plan, however, involves a slight loss of copper, and a more economical, but less ready method is to use less oxide of copper, or even some hydrated dinoxide of copper, and agitate the liquor in contact with the air. So we shall have—

$$2\,Fe\,Cl + 2\,Cu\,O + O = Fe_2O_3 + 2\,Cu\,Cl;\ \text{or,}$$

$$Fe\,Cl + Cu_2O + O_2 = Fe_2O_3 + 2\,Cu\,Cl.$$

After settling and decantation, the solution is treated with just enough milk of lime to precipitate the copper as pure dinoxide. Thus:

$$Cu_2\,Cl;\ Na\,Cl + Ca\,O = Cu_2O + Na\,Cl;\ Ca\,Cl.$$

The residual solution of mixed chlorides is returned to the furnace tank, to be used over again. The dinoxide of copper is dried, and is then ready either to be used for the preparation of copper salts, or to be reduced to the metallic state.

The Committee take on trust the exactness of the above method of precipitating the iron, as the nicety of these methods cannot easily be proved in the time afforded by an ordinary session. But, except in certain cases, it is not necessary to get rid of the dissolved iron; for, instead of precipitating the copper as dinoxide, it may sometimes be more advantageous to throw it down as metallic copper, in the way of "cementation." Then the iron originally present, as well as that

* Pogg. Annal. XLIX, 401.

taken up in precipitation, may be separated by lime, so as to fit the saline solution for being used again.

The Water Furnace process seems to be especially suitable for very poor ores, as it extracts the copper completely, after a mere roasting heat, without the addition of fluxes; while in the common methods of smelting, the gangue requires an intense heat for its fusion and removal. And when the reduction by metallic iron, in the way of "cementation," is to be resorted to, Professor Langley calls attention to the manifest advantage of having in solution a dichloride which requires for its decomposition only half as much iron as a protosalt of copper.

The *commercial value* of this mode of reducing copper ores can, of course, be arrived at only after long continued working on the manufacturing scale. Upon this point, the Committee express no opinion; but they cheerfully bear witness to the great scientific interest of the process, and of the possibility of carrying it out in practice they have become assured, by seeing in actual operation the large experimental furnace built by Messrs. Whelpley and Storer. The Committee were much impressed with the elegance of the novel reactions which take place in the Water Furnace, and the facility with which they were carried out in Professor Langley's lecture-table demonstrations. They hope that the researches will be continued with particular reference to ores containing silver or gold, since the study of the reactions of such ores, in the Water Furnace, can hardly fail to develop facts of much chemical importance.

JOHN M. ORDWAY, *Chairman.*

FRED. E. STIMPSON, *Secretary of Committee.*

(Continued from Vol. LIII., page 406.)

LECTURES ON MINERALOGY.

By THEODORE D. RAND.

LECTURE I—Continued.

In similar uncertainty is the nomenclature of minerals. Originally, minerals were named from their common names, as epsom salts, copper pyrites, heavy spar; or their chemical composition, as sulphate of magnesia, carbonate of iron, subchloride of copper, sulphate of baryta; and when these were not applicable, from some prominent characteristic or locality, as Staurotide, Kyanite, Labrador Feldspar, &c., when the name was not common, but derived, the termination, ite or lite, from

λιθος, was added. Later, naming after individuals became common, not only in the case of new species, but to obtain the favorite termination, *ite*, new names were applied to many of the old species, often many times over, until, for six hundred species, we have twenty-seven hundred names. It is to be regretted that Professor Dana, whose works are undoubtedly the standard in this country, has permitted this in his volume, as any slight advantage is far more than counterbalanced by the confusion caused by the changes. Thus: Electric Calamine, in third edition, is Calamine in the fourth; Calamine, in third edition, is Smithsonite in the fourth; Heavy Spar, in third edition, is Barytes in the fourth; Brown Hematite, in the second edition, is Limonite in the fourth; Copper Pyrites, in the second edition, is Chalcopyrite in the fourth, &c., &c., while, seemingly, as far as possible, the names expressing the chemical composition are abandoned, to give place to unmeaning names. Chloride of Lead, is Cotunnite; Chloride of Silver, is Kerargyrite; Hydrate of Magnesia, is Brucite; Boracic Acid, is Sassolin; Sulphate of Lead, is Anglesite; Sulphate of Nickel, is Pyromeline; while others, as Selenate of Lead, Native Alum, Copperas, Sulphurous Acid, Glauber Salt, Sulphuric Acid, Common Salt, are retained.

I have spoken thus at length, because I feel that these are obstacles most injudiciously placed in the path of every beginner in the science, obstacles to surmount which will require time and patience, far better devoted to advancing the science. It is to be hoped that some day, a Cuvier among the mineralogists may arise and reduce our chaos to system.

Mineralogy, to the vast majority of persons interested in natural science, who can devote only a small portion of their time to such study, presents advantages possessed by no other branch. The Botanist or the Zoologist must very speedily prepare his specimens, or they will perish in his hands. He must seek his treasures at the proper seasons of the year—a few days too early or too late, and he might as well not seek at all. The mineralogist, on the contrary, returning home weary and laden with his spoils, may leave them untouched for months, without loss or deterioration, until leisure permits their examination. No matter what the season of the year, or the condition of the weather, if snow be off the ground, he can reap a harvest, and may sometimes, if in a rich mineral region, like our own vicinity, within a few miles find more than one-tenth of all known species, and these in many very interesting varieties.

I may here state, that the number of species in my collection,

found in Philadelphia and adjacent counties, is one hundred and nineteen, and, of varieties sufficiently distinct to have particular names, one hundred and sixty.

Many persons have asked the question, How do you find minerals? Where do you look? How do you know where to go? As some may read this who have never enjoyed the pleasure of a mineralogical excursion, permit me to describe one. We will take it up the Schuylkill. Early in the morning, two individuals, each with a black bag, looking suspiciously empty, might be seen upon the cars of the Norristown Railroad. In the course of time, they arrive at the romantic village of Manayunk. Here, leaving their conveyance, bag in hand, they ascend the hill. Suddenly, one cries out, "Here is fine Bucholzite." Down go both bags, out come hammers and cold chisels, and soon some of the stones in the gutter are broken to fragments, carefully wrapped in paper, and transferred to the bags, amid the wondering gaze and remarks of men, women and children, who if uncharitable, think our friends are crazy; if charitable, that they have found a gold mine. This locality exhausted, the march is taken up along the railroad, where all prominent rocks are examined, but nothing of much interest found until the soap stone quarry is reached. Here another search takes place, with great success, and a cry of "I have a fine piece of Talc," or "I have Dolomite," is intermingled with an "Oh!" the inexperienced mineralogist finding the treachery of steatitic rocks, as his foot slips, and he fully realizes, if he never knew before, what is meant by the attraction of gravitation. Here however, the true mineralogist will show himself. He may tumble, but his hammer and his specimens go with him, carefully held, and if he be bruised, the specimens are not.

By this time, a four-mile walk and hard work among the rocks have convinced our mineralogists that some creature comforts would not be inappropriate. A comfortable place by a spring of fine water is found, again the bags are opened, and a frugal repast comes forth, seasoned, however, with that best of all spices which comes not for the bidding, and which wealth cannot purchase.

Dinner finished, our friends walk up the river to Spring Mills. Here the iron furnaces are interesting in themselves, and the heaps of coal, iron ore and limestone furnish many more specimens. The black bags are full, looking as if their sides would burst. Pockets also are called into requisition. Laden with all they can carry, our friends seek the station, and in due time reach home, fatigued in body but refreshed in mind, ready for a good supper and a sound sleep, with a

good time over their treasures in prospect for a convenient season in the future.

We will now consider the most important characteristics of minerals. These may be enumerated as follows:

I. Depending upon Light.

A. Color; very variable and uncertain.

B. Streak (or color of the powder of the mineral); quite constant and valuable.

C. Refraction—Polarization; rarely shown, except in prepared specimens.

D. Play of Colors—Opalescence; rare, but characteristic.

E. Iridescence; Usually *accidental*, due to fissures (quartz), or to *superficial oxidation* (iron ores—anthracite).

F. Phosphorescence; rare, but characteristic.

G. Fluorescence; very rare, but characteristic.

H. Lustre; constant and important.

II. Depending upon Crystalline Form.

A. Crystals; bounded by natural symetrical faces. Frequently obscure, but when apparent the most definite characteristic except chemical analysis.

B. Cleavage, or facility in splitting in one or more directions owing to crystalline structure; very constant and important.

III. Depending upon Cohesion.

A. Hardness;
B. Fracture;
C. Tenacity;

} If the mineral be undecomposed, constant and important.

IV. Specific Gravity; ditto.

V. Taste, Odor; not common—when apparent, valuable characteristics.

VI. Chemical.

A. Action before blow-pipe; very important.

B. Action with acids; often important.

C. Chemical analysis; first of all in importance.

A few of these characters will justify a more detailed study, even in the brief limits allowed to our subject.

Streak.—This is shown by powdering a fragment of the mineral in a mortar, or more readily and equally well by rubbing the mineral upon a surface of unglazed china. The broken edge of thick white stoneware is excellent. Thus magnetic iron and specular iron, as well as many other species, sometimes very closely resembling each other, may be instantly distinguished.

Phosphorescence—Is shown when some varieties of fluor spar and calcite are heated just below redness. The mineral glows with a beautiful light;—with fluor, generally green, with calcite, yellow.

Crystalline Form.—Crystals have been divided into several classes, founded upon the relative position of certain imaginary lines, called axes, connecting the opposite angles, or centres of opposite faces, of the crystal. Their study is of the greatest importance to the mineralogist, but we have time to consider only one of these classes as a type of all. We choose the most simple—the monometric—so called from two Greek words signifying equal measure, because the axes are at right angles to each other and of equal length. Of this class the cube and the regular octahedron are the types. If lines be drawn connecting the centres of opposite faces of a cube or the opposite angles of a regular octahedron, it is evident that such lines will cross each other in the centre of the crystal at right angles to each other and that they will be of equal length. Now if the angles or corners of a cube be equally and evenly sliced off, as any one may try with a piece of chalk or potatoe, an octahedron will result. If the angles of an octahedron be similarly treated, a cube will result. Again, if instead of the angles of the cube or octahedron, the *edges* be equally cut off, a rhombic dodecahedron will result from either. Similarly, other modifications of the same kind may be made, forming crystals of different forms, but all with the three equal rectangular axes, and therefore all belonging to the monometric system. Sometimes the same species is found crystallized at the same locality in several of these forms and in all stages of progress (if the expression may be used) from each to the others, as, for instance, pyrites from Cornwalls, in Lebanon County and Texas in Lancaster County, Pa. Cleavage is a consequence of crystalline structure, and is generally parallel to one or more faces of the crystal. Thus galena and common salt, belonging to the monometric system, cleave parallel to all the faces of the cube. Fluor spar, of the same system, though almost invariably crystallized in cubes, cleaves parallel to the faces of an octahedron, while zinc blende, of the same system, has a cleavage parallel to the faces of the dodecahedron. Cleavage is the more important from its being very frequent, even when external crystalline form is wholly absent.

The Blowpipe affords the most ready means of distinguishing species not determined by external characters. It consists of a bent tube, having a mouthpiece at one end, a fine and smooth orifice at the other; a chamber in the lower part of the tube to receive any

moisture condensed from the breath is very useful. A little practice will enable the student to keep up an uninterrupted stream of air by means of the muscles of the cheeks, the lungs being supplied through the nostrils. The jet being directed through a small flame gives a cone of intense heat. A splinter of the mineral under examination is placed on a piece of charcoal, mica, or kyanite, or, preferably, in platinum pointed forceps, and held in the blow-pipe flame. The effect, (whether the mineral be fusible or not,) the color of the flame, if any, and the color of the specimen is noted. If these be insufficient to determine the species, and the mineral be supposed to contain an easily reducible metal, a fragment is heated in a cavity on a piece of charcoal, with the addition, if necessary, of some carbonate of soda. This will determine the presence or absence of many of the metals. Finally, fragments may be dissolved in globules of borax, carbonate of soda, or microcosmic salt (phosphate of soda and ammonia), fused on loops of platinum wire. With these many characteristic reactions may be observed, varying as the globule is placed nearer the flame, where there is unconsumed carbonaceous matter, and hence a reducing atmosphere, or further from it, where there is high heat with excess of air, and where, consequently, oxidation proceeds rapidly. The flame of a lamp or candle will answer for the blow-pipe, but gas is better. Best of all is a very small Bunsen burner, in which, at will, the flame can be made highly carbonaceous and suitable for reduction, or (by mixture of the gas with air before burning) suitable for oxidation.

Acids.—The most common use of acids is to determine whether a mineral is a carbonate or not. In the former case, on moistening, the mineral effervescence is produced, owing to the escape of carbonic acid. Hydrochloric acid should be used, and it is sometimes necessary to powder the mineral and apply heat.

Chemical Analysis determines the elements composing the mineral and their relative quantity. It is a difficult but most interesting study, but beyond the limits of this course.

In the determination of a mineral species we feel greatly the want of that important characteristic of species in the animal and vegetable kingdoms, viz.: the perpetuation of their kind. We also meet the difficulty that even the hardest minerals slowly decompose, as, for instance, beryls, at a quarry in West Philadelphia, are found quite decomposed and soft. The rules as to a species, according to the best authorities, are, first, uniformity in chemical formula; second, if

crystallized, uniformity in crystalline form. Strict application of these rules reduces all mineral species to about six hundred. Claims are frequently made for new species, and new names given, upon mere differences in color, structure, &c., with about the same force as a black horse, or a large one, can be called of a different species from a white or a small one.

(To be continued.)

EDUCATIONAL

(Continued from Vol. LIII., page 412.)

THE MAGIC LANTERN AS A MEANS OF DEMONSTRATION.

NEXT to the jet, both in sequence and in actual position, comes the lime. This is used in a variety of forms, and is moved automatically or by hand, in various manners; but we shall confine ourselves to a description of those points and arrangements which we have found in practice to give the best result with the greatest economy of apparatus and of labor. In the first place, we believe that a flat surface is a better source of light for lantern experiments, than a cylinder or ball. We therefore recommend square prisms, to which a vertical movement only is given by clock-work or by the hand, a readjustment to a fresh face being made when one is exhausted. The ease with which these prisms may be cut with a hand-saw from a block of lime, is no small recommendation.

Where it is desirable to obtain the most perfect reliability and steadiness of automatic regulation in the light, as in the use of the gas microscope and polariscope, &c., where the whole attention is needed elsewhere, the best apparatus is a clock-work combination, by which a disk of lime about three inches in diameter and one and one-fourth inches thick, is caused to move in front of the jet, so that this would trace on its surface a series of spirals. With such an arrangement, the same piece of lime (if of good quality) may be used on the same face several times, and then turned in its holder and used on the other face.

We have thus, in making experiments with new lenses, objects and apparatus, run the light for more than four hours without any need of adjustment, except a touch on the stop-cocks three or four times,

to compensate some alteration in the pressures. We have used the same piece of lime, also, as often as six times, and about one and a half hours each time. This depends, however, entirely upon the character of the lime. Some will crack and fall out if the holder is removed for preservation.

To preserve the lime disks for repeated use, we have several straight-sided glass jars with ground edges, of about one pint capacity. A little sand being placed in these, we deposit the lime-holder and disk, fresh and hot from the lantern, in the jars, and cover them with pieces of ground glass fitted in caps of wood, which prevents them from being knocked off in moving. To describe the clock-work in detail, would require many words and elaborate drawings, and would, beside, be of little use; for those requiring these parts must get them made by practiced hands. We will therefore only give such a general account as will enable any competent clock-maker to construct what is needed. Two excellent plans are largely in use, and from our experience with both, we cannot give any preference to either. One is arranged by taking an ordinary clock-work, mounting it on wheels and securing it on a brass plate, so that it may run across the same through a space of some two inches. The axle of the hour-wheel is carried through the back, and a crank terminating it is attached by a connecting-rod with an upright post on the bed-plate before mentioned. The clock thus "hitched" to a post by its hour-wheel, is dragged back and forth as this last revolves. Proper supports or open journals are then arranged for the lime-holder, which is a sheet iron cylindrical box riveted to an axial shaft provided with an arbor near one end, into which the pinions of the hour-wheel work when it is in position.

The jet is then adjustably supported on the front of the bed-plate, and the whole apparatus arranged in the lantern with the necessary appliances for its support and adjustment.

In the other form of apparatus, the clock-work is fixed and the supports of the lime-holder are movable about an axis a little distance below and to one side; motion is given to the lime-holder through an intermediate pinion on the same frame, by a pinion-wheel on the hour-axle as before; but in this case this pinion-wheel is set excentrically, by reason of which it not only rotates the lime, but pushes it away and lets it fall back. The combination of these motions, as before, produces a spiral movement with reference to the jet.

Messrs. Queen & Co. also furnish a modified form of this last, in which the lime-holder is moved directly from an excentric friction-

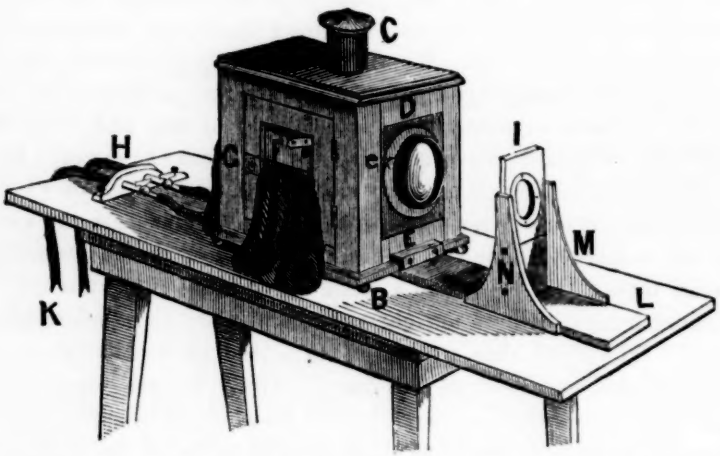
wheel on the hour-axle, working on a large friction-wheel attached to the axis of the holder. This somewhat simplifies the arrangement.

The Lantern.

The lantern, or box to inclose the light and act as support to the condensing lenses at least, if not to the entire apparatus, next claims our attention.

We will describe, in the first place, a form which experience has shown us to be well adapted to a great variety of purposes, and which, without unnecessary expense, is provided with every desirable convenience and facility of operation. Fig. 10 shows one of these

Fig. 10.



boxes with its table condenser, and other appliances which we shall describe in their place. Such a box as is here shown, costs at the present time, without its iron roof, worth about $2, no more than $8; so that this item, in comparison with the other expenses of a good instrument, is but trifling at most. Its general structure is clear from the drawing, but we may mention that it has three doors, each of which is provided with a hole in the panel, covered by a curtain, as shown in the cut, by which the hand may be introduced. This is not essential where the lime-light is employed, but is requisite for certain experiments with the electric light, which we will mention at a future time, and is occasionally convenient even in the first case.

The doors are secured with a fastening known as the "Flush ring catch," which being perfectly flush, without any projection, is convenient in packing, never catches upon anything, and opens without the least shock or jar. In this fastening, a countersunk ring is drawn

out by the finger, and by this motion releases the bolt. Small peep-holes are also arranged in each door, covered with squares of colored glass, crimson and dark blue, superposed in each case, which are chiefly used with the electric light, and being supported in grooved pieces on the inside of the doors, may be pushed away from the holes when desired.

On the bottom of the box two strips of wood are nailed, between which slides forward and back a square block on which is supported the apparatus carrying the light. Two holes in the sill under the back door serve to introduce the flexible tubes carrying the gases from the stop-cocks which are attached to a piece of wood, H, itself screwed to the table. Several ¾-inch holes are made in the bottom of the box for ventilation, a very important point, as without some such provision the lantern will become filled with steam formed by the burning jet. The doors must, of course, be hinged on the side towards the condenser, as otherwise the least opening of them to look after the jet, will throw a glare upon the screen quite fatal to the picture.

The condenser, D E, (to be more fully described in future,) is fastened to the front of the box by two thumb-screws, one of which is shown at *c*.

The lenses, &c., may be attached by means of brass tubes, to the cell of this condenser; but where it is desired to adopt the lantern to a great variety of uses, such as will be described in these papers, it is far better, or rather essential, to have a separate support for the objectives, with a free space for insertion, arrangement and removal of "objects" between. For this purpose, the most convenient and "flexible" (we use the word in a figurative, not literal sense) arrangement, is that shown in the cut. A flat strip of hard wood, such as black walnut, mahogany or cherry, is attached to the front of the box, as shown at E L, and upon it slides an upright frame, M N, into the grooves of which drop pieces provided with rings like I, fitting the various instruments to be employed. Thus one piece suits the tube containing the objectives for the magic lantern, another fits the stage and objectives required for the microscope, another the polarizing appliances. By this means the most rapid and easy change of adjustment can be effected at the insignificant cost of a few square blocks of wood with holes cut in them. Each system has its own block, and when we change, it is only necessary to pull one out, and drop another into its place.

Some objects are set on little tables or rather benches, placed at

will, immediately in front of the condenser, D E, while pictures are supported by means of a frame which is attached directly to the condenser by a ring which slides tightly over it.

These details we will, however, reserve for discussion when the special experiments and their arrangements are described.

(To be continued.)

Franklin Institute.

Proceedings of the Stated Monthly Meeting, June 19th, 1867.

THE meeting was called to order with the President, Mr. J. V. Merrick, in the chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported, that at their stated meeting, held June 12th, inst., donations to the library were received from the Royal Astronomical Society, the Chemical Society, the Institute of Actuaries, the Statistical Society, and the Society of Arts, London, and the Association for the Prevention of Steam-Boiler Explosions, Manchester, England; the Natural History Society, Toronto, Canada; Young Men's Association, Buffalo, New York; the Sheffield Scientific School of Yale College, New Haven, Conn.; Hon. John L. Dawson, Penna.; Wm. Holden, Esq., Prof. Henry Morton and the Board of Health, of the City of Philadelphia.

And to the Cabinet of Models from Messrs. W. Barnet Le Van and Frederick Graff, Philadelphia.

The various Standing Committees reported their minutes.

The Special Committee on Experiments in Steam Expansion, reported progress.

The Committee appointed to prepare a Memorial to Congress, asking for the establishment of an uniform code of danger signals, reported that they had prepared the following Memorial, which had been properly engrossed, and was now ready for the signatures of the officers and seal of the Institute.

HENRY MORTON,
THOMAS SHAW,
JOHN C. CRESSON.

MEMORIAL

ASKING THE ESTABLISHMENT OF AN UNIFORM CODE OF DANGER SIGNALS.

To the Honorable, The Senate and House of Representatives of the United States of America, in Congress assembled:

The Memorial of the Franklin Institute of the City of Philadelphia respectfully represents:

That they have had in consideration the various sound and color signals employed in running trains upon the Railroads of the United States, with a view to ascertain their uniformity.

A Committee of the Institute, to whom the subject was especially referred, report that they have found great want of regularity in the signal systems adopted and used upon different railroads.

As the employés of the various roads are frequently changed from one road to another, the unavoidable confusion and mistakes occurring under the present lack of uniformity, are fruitful causes of danger and accident to the traveling public, and detrimental to the interests of the companies.

Your Memorialists would, therefore, earnestly impress upon the attention of your honorable bodies the necessity for early legislation in a matter already of very great national moment, and the importance of which is constantly increasing with the rapid growth of our railroad system.

To this end, they respectfully suggest that a law be enacted by your honorable bodies, enforcing an uniform system of signaling upon all the railroads in the United States.

The arrangement embodied in the Act hereunto appended, embraces the signals most generally in use at present, and which seem to your Memorialists most fit for the purpose.

AN ACT TO ESTABLISH UNIFORMITY IN RAILROAD SIGNALS.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That from and after the —— day of ———, eighteen hundred and ———, the following rules and regulations for signaling shall be adopted upon all railroads operated by steam in the United States:

REGULATIONS FOR RAILROAD SIGNALING.

Rules concerning Whistle Signals.

The signal for "Up Brakes," shall be *one* sound of the whistle; "Down Brakes," *two* sounds of the whistle; and to *back* the train, *three* sounds of the whistle.

In case of cattle on the track, and on approaching crossings and curves, there shall be *one* long sound of the whistle.

To call in flagman, or the crew of the train, *one* long sound of the whistle.

On approaching stations, *one* long sound of the whistle.

For employés of the road to go to the assistance of a train, *three* long sounds of the whistle.

Rules concerning Bell Signals.

The engine bell shall be rung on starting the train from all stopping places.

Signals to the engineer shall be as follows:

To start the train, one sound of the bell; to stop the train, two sounds of the bell; to back the train, three sounds of the bell; to slacken speed, three sounds of the bell.

Rules concerning Flag Signals.

In signaling to trains during the daytime:

To indicate "Danger," a red flag shall be used.

To indicate "Caution," a blue flag shall be used.

To indicate "All Right," a white flag shall be used.

When an extra train is following on the same time-schedule, two red flags shall be carried on the front of the engine of the preceding train.

When an extra train is following, which will keep away from all trains, two blue flags shall be carried on the front of the engine of the preceding train.

Two red flags shall be placed on the rear end of the last car of every day train, to enable the engineer to see that all the cars are securely coupled.

Rules concerning Lantern Signals.

In signaling to trains during the night time:

To stop the train, or to indicate "Danger," and at all flag stations and crossings at grade, a red light shall be used.

To indicate "Caution," a blue light shall be used.

To indicate "All Right," a white light shall be used.

When an extra train is following on the same time-schedule, two red lights shall be carried on the front of the engine of the preceding train.

When an extra train is following, which will keep away from all regular trains, two blue lights shall be carried on the front of the engine of the preceding train.

Two red lights shall be placed on the rear end of the last car of every night train, to enable the engineer to see that all the cars are securely coupled.

Rules concerning Motion Signals.

To start the train, one arm held at right angles to the body.

To stop the train, both arms held at right angles to the body.

Generally, all violent motions made by any person to a moving train, shall be interpreted as signals to stop.

Detonating signals, or torpedoes placed upon the track, shall be interpreted to indicate danger.

The Committee appointed to consider the subject of the proper proportions of safety-valves for steam-boilers, and the best regulations concerning steam pressure gauges, reported as follows:

[This report not being received from the committee, its publication must be deferred.—ED.]

The Committee appointed to draft an Ordinance providing for the Inspection of Steam Engines and Boilers in the City of Philadelphia, reported the following draft of ordinance, which they recommended to the Institute for adoption, and requested to be discharged from further consideration of the subject.

J. V. MERRICK, *Chairman.*
ROBERT BRIGGS,
WILLIAM SELLERS,
COLEMAN SELLERS,
WM. B. LE VAN,
JAMES MOORE,
SAMUEL HART,
THOMAS SHAW,
Committee.

AN ORDINANCE

To carry into effect an Act of Assembly to authorize the appointment of an Inspector of Stationary Steam Engines and Steam Boilers in and for the City of Philadelphia, approved the 7th day of May, 1864, and to establish rules and regulations as empowered by said Act.

SECTION I.

The Select and Common Council, of the City of Philadelphia, do Order:

There shall be an Inspector for steam-engines and steam-boilers in and for the City of Philadelphia.

The Mayor shall appoint an Advisory Commission, consisting of five persons, either practically engaged in the manufacture of steam-engines and boilers or scientific experts familar with their management, who shall give their written consent to serve on such commission without compensation, and perform the duties as hereinafter provided.

Whenever the Mayor shall have appointed all the members of the Commission as aforesaid, he shall call them together at such time and place as he may select for the purpose of organization, and the adoption of such By-laws as to them may seem useful.

The Mayor is hereby authorized to have suitable accommodations provided for the use of said Commission, and to furnish them with the requisite stationery.

To this Commission the Mayor shall refer for examination such person or persons as he may consider suitable candidates for the office of Inspector of steam-engines and boilers, and the said Commission shall inquire into the qualifications of such candidate or candidates without unnecessary delay, and report the result thereof to the Mayor.

In case the Commission shall not report upon said candidate or candidates within thirty days from the time when they have received notice of reference, or shall not have reported satisfactory reasons for longer delay, the Mayor may discharge said Commission and appoint another in its place.

No appointment of Inspector shall be confirmed by Select Councils until the nominee shall have been reported by the aforesaid Commission as qualified for the position.

Whenever an appointment of Inspector shall have been confirmed by Select Councils, the duties of the Advisory Commission shall cease and determine; and all books, papers and records shall be deposited in the Mayor's office for the use of any subsequent Commission.

Section II.

Qualifications of the Inspector.

The Inspector shall be a person who has had practice in the construction of steam-engines and boilers, and possesses such knowledge of bracing and of thickness of iron to safely withstand given pressures, and of the general designing of steam-boilers, together with experience in their management, as will enable him to fulfill the duties of the position.

Section III.

Duration in Office of the Inspector.

The Inspector shall enter upon the duties hereinafter directed to

to be performed by him, on the first Monday of July, annually, and shall hold until his successor shall be duly qualified.

Before entering upon the duties of his office, he shall give bonds in the sum of ten thousand dollars ($10,000), with security to be approved by the Mayor.

SECTION IV.

Appointment of Assistant Inspectors, their duration in office, removal, &c.

There shall be four persons, skillful and competent, appointed by the Inspector, with the approval of the Mayor, to act as Assistant Inspectors; and the said Assistant Inspectors shall enter upon the performance of their duties immediately upon such approval, and hold until the termination of the time of holding of the Inspector appointing them, or until their successors be appointed; unless suspended by said Inspector, and, with the approval of the Mayor, removed; and no suspension or removal shall be made except for cause.

SECTION V.

Providing Subordinate Officers.

The Inspector shall employ one competent workman to aid each Assistant, and shall employ one clerk, who shall also be a draughtsman, and one person to act as messenger to his office.

SECTION VI.

Providing Office Rooms.

There shall be provided and allotted to the Inspector, by the Committee of Councils on City Property, one or more suitable rooms, to be occupied as an office.

SECTION VII.

Providing Official Seal.

The Inspector shall cause to be prepared, and, with the approval of the Mayor, shall adopt an emblematic seal, to be used in the performance of his duties.

SECTION VIII.

Relating to Proving Instruments.

The Inspector shall procure five sets of accurate gauges, pumps, and other testing apparatus, and cause proper arrangements to be made for their preservation in his office.

Section IX.

Relating to Stationery, &c.

The Inspector shall procure suitable record books, certificate blanks, and other stationery needed for the archives and business of his office.

Section X.

Providing Transportation.

The Inspector, or any of his Assistants, under his order, is empowered to incur the necessary expenses of transportation.

Section XI.

Registration of Steam-Engines and Boilers.

The user or users of every stationary steam-engine and steam-boiler, within the limits of the city of Philadelphia, shall, within thirty days after notice, published in the newspapers by the Inspector, report in writing, to the office of the Inspector, the location of every such engine or boiler in use by him or them, and the business or purpose for which the engine and boiler are used.

The user or users shall in like manner notify the Inspector of any new steam-engines or steam-boilers proposed to be erected or operated, so that the same may be inspected before using.

Section XII.

Duties of Inspection.

The Inspector shall by himself or his assistants, at least once in every year, examine personally each stationary steam-engine and its pipe connections, and shall determine upon the safety and competency of the same, at the pressure and speed specified in his certificate.

He shall in like manner examine each stationary steam-boiler with reference to the following particulars:—1. The setting. 2. The form and construction. 3. Thickness and kind of plates employed. 4. Their apparent condition as regards imperfections, wear or injury. 5. In all new boilers he shall require that each sheet shall be stamped with its maker's name and the quality of material, in accordance with the inspection laws of the United States for steamboats.

He shall also inspect the feeding apparatus, together with the various attachments required to be placed on the boilers, and their pipe connections. He shall also test each boiler by hydrostatic test, to

a pressure one-third ($\frac{1}{3}$) greater than that at which the boiler is to be used, as specified in his certificate.

In case the inspection prove satisfactory, the Inspector shall furnish a certificate to that effect, which certificate shall state the maximum pressure at which the boiler shall be worked, and such other conditions as he shall deem essential to the safety and competency of the engine and boiler. This certificate shall be signed by the Assistant Inspector by whom the examination has been made, and countersigned and sealed by the Inspector.

If at any time the Inspector shall deem the engine-driver incompetent or unreliable, he may withhold or withdraw his certificate.

Whensoever, upon inspection, any engine or boiler is found to be deficient in any regard, so that a certificate for competency or safety cannot be given, a written report of the condition of the engine or boiler shall be furnished to the user or users, specifying the repairs or changes necessary, which shall be signed in like manner to a cerficate.

The Inspector shall report to a magistrate, and have bound over for trial, any person or persons who may have rendered themselves liable by infraction of any provision of this Ordinance, as provided in Section IV. of the Act of May 7th, 1864.

The Inspector shall notify in writing the user or users of any engine or boiler, that he will, within ten days of the date of such notice, inspect the same, and the user or users may select such day for the inspection as may be most convenient, within the time so designated.

He shall, besides the annual inspection hereinbefore provided, inspect the boilers or engines of any person or persons using the same, upon their written application at any time, ten days notice being given.

The Inspector shall report quarterly to the Mayor for communication to Councils, the number of engines and boilers examined and the receipts and expenditures of the office, and annually the operations of his office during the past year.

He shall examine into the cause of all disasters and explosions occurring to engines and boilers, within the limits of the city of Philadelphia, and shall promptly report the same to the Mayor and Councils.

Section XIII.

Attachments and Indicators.

There shall be, for each boiler or series of connected boilers, at least one efficient feeding apparatus, and in case there be but one

such apparatus, and it be worked by an engine employed for other purposes, this feeding apparatus shall be of such character and construction that it can be examined and repaired in all its parts while the engine is in motion.

Each boiler shall have upon it three gauge-cocks, and in addition thereto, some visible means of indicating the water-level.

Every boiler when fired separately, and every set or series of boilers when placed over one fire, shall have attached thereto, without the interposition of any other valve, two or more safety-valves, the aggregate area of which shall have such relations to the area of the grate and the pressure within the boilers as is expressed in schedule A, attached to this Ordinance; and every safety-valve shall have an arm or lever, distinctly notched and marked with five-pound or ten-pound divisions, and shall have but one pea or ball for a weight; and the arm shall not have a greater length than will allow the pea to be placed so as to produce on the boiler the maximum pressure which the certificate authorizes to be carried.

There shall be for each boiler, or series of boilers connected in one range, at least one good and reliable steam pressure gauge, attached without the intervention of any valve except its own.

Every range of boilers over one fire shall be so connected by steam and feed pipes, that an uniform level of water may be maintained therein.

Section XIV.

The Inspector or his Assistants shall not, directly or indirectly, be interested in the manufacture or sale of any of the appliances connected with steam-engines and boilers.

Section XV.

Charges for Inspection.

The charges for inspection, which shall be paid by the user or users of engines and boilers in use by any single person, firm or company which may be inspected in one inspection, shall be as follows, viz: for all the engines, the sum of three dollars ($3), and for each and every boiler, the sum of three dollars ($3), with the addition of twenty cents (20 c.) per square foot of grate surface; provided, that when any boiler or boilers are heated by the waste heat of furnaces, the proper grate surface shall be estimated and certified by the Inspector, and the fees assessed thereupon.

SECTION XVI.

Salaries.

The salary of the Inspector shall be, for the time he shall hold office, at the rate of four thousand five hundred dollars ($4500) per annum.

The salary of each Assistant Inspector shall be at the rate of twelve hundred dollars ($1200) per annum.

The salary of the Messenger shall be seven hundred dollars ($700) per annum, and the salary of the Clerk shall be twelve hundred dollars ($1200) per annum.

SECTION XVII.

Warrants and Moneys.

All moneys collected for charges shall be paid over to the City Treasurer.

Warrants for payment of salaries and expenses shall be drawn by the Mayor, after being approved by the Inspector.

The Secretary's Report on Novelties in Science and the Mechanic Arts was then read.

Deferred business being then in order, it was moved that the Draft of Ordinance presented by the committee should be acted upon; this was therefore read by sections and adopted with the following amendment:

The second clause of section 16 was made to read, "The salary of each Assistant Inspector shall be, for the first year, at the rate of twelve hundred dollars ($1200) per annum; second year, $1300; third year, $1400, fourth year and after, $1500 per annum."

After having been thus read and adopted by sections, the Draft of Ordinance was finally adopted as a whole; and, on motion of Mr. Coleman Sellers, it was resolved: That the Secretary be instructed to forward a copy of the Draft of Ordinance, as adopted, to the Committee on Law, of Select and Common Councils, with the request that it may be brought to the attention of Councils at as early a date as possible.

This being duly adopted, the meeting was, on motion, adjourned.

HENRY MORTON, *Secretary.*